Adoption and adaptation of innovations - assessing the diffusion of selected agricultural innovations in Africa

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Abbreviations

EU	European Union
ZALF	Leibniz Zentrum für Agralandschaft, Forschung
CA2Africa	Conservation Agriculture in Africa
QAToCA	Qualitative expert Assessment Tool for CA adoption
CA	Conservation Agriculture
EU FP7	European Union Framework Programme 7
SSA	Sub-Saharan Africa
FAO	Food and Agricultural Organisation
RRA	Rapid Rural Appraisal
PRA	Participatory Rural Appraisal
CIMMYT	International Maize and Wheat improvement Center (Centre International de Mejoramiento de Maiz y Trigo)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ZCATF	Zambian Conservation Task Force, Zimbabwe Conservation Agriculture Task Force
CFU	Conservation Agriculture Unit
TLC	Total Land Care
GTZ	German Organization for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit)
CARITAS	Congregation Around Richmond Involved to Assure Shelter
NASFAM	National Small Farmers Association of Malawi
FICA	Flemish International Cooperation Agency
MACO	Ministry of Agriculture and Cooperation, Zambia
CLUSA	Cooperative League of the United States of America
IFAD	International Fund for Agricultural Development
OXFAM	Oxford Committee for Famine Relief
INERA	National Research Institute for Agriculture and Environment (Institut National de l'Environnement et la RechercheAgronomique)
UNPCB	National Union of Cotton Producers, Burkina Faso (Union, Nationale,Producteurs, Coton, Burkina, Faso)
USAID	United Sates Agency for International Development
FAO	Food and Agricultural Organization
FIDP	Farm Income Diversification Programme
GART	Golden valley Agricultural Research Trust
NGOs	Non-Governmental Organizations
PRODS/PAIA	Integrated Agricultural Production Systems (PRODS) as a Priority for Interdisciplinary Actions (PAIA)

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Special acknowledgement equally goes to my three supervisors: Prof. Dr. Klaus Müller, Prof. Dr. Andrea Knierim and Prof. Dr. Harald Kähele for all the intellectual support and for allocating time to read through this work. To all co-authors of my published papers which make up this project, I wish to say thank you for the positive suggestions and support during the writing and publishing process. Finally, my acknowledgement goes to my wife (Zelda) and two daughters (Glenis and Ashley) for their endless love which kept me motivated to the end of this project.

Summary

This PhD thesis follows a cumulative approach comprised of a collection of peer reviewed journal articles. The focus of the work is on adoption and diffusion processes of innovations with emphasis on the field of agriculture. With the intention of examining a cross cutting picture of innovations from aquaculture to crop production and soil science, in this thesis, Fish Farming and Conservation Agriculture are both selected and examined as examples of agricultural innovations in Africa. Apart from chapter 1 (general introduction) which highlights the general objectives, research design and structure of the thesis, chapter 2 consists of an in depth review of selected adoption theories and concepts which are later used as conceptual frameworks in subsequent chapters. The other chapters correspond to three peer reviewed articles which form the core of this work. These include: a) chapter 3 (article I), which examines the adoption and diffusion processes of Fish Farming in Cameroon, b) chapter 4 (article II), which presents the development and exemplary application of a Qualitative expert Assessment Tool for CA adoption (QAToCA) in Africa and, c) chapter 5 (article III), which reports on the wider application of QAToCA approach to assess the adoption and diffusion potential of CA in five case studies across SSA.

Specifically focused on Fish Farming and Conservation Agriculture as examples of Agricultural innovations in Africa, this work has 1) partly demonstrated that the reality of the adoption and diffusion of agricultural innovations in Africa is a more complex issue, 2) improved on the knowledge and understanding of contextual factors influencing the adoption and diffusion of these innovations in Africa and, 3) developed and contributed to a new methodological approach in this field of study. Apart from literature review on theories and concepts as well as on the two selected innovations, empirical data collection for this work was derived mostly with the use of Participatory Rural Appraisal (PRA) methods such as semi structured farmers and expert interviews, focus group discussions, key informant interviews and participant observations. The QAToCA approach, developed as a participatory assessment method within this study (chapter 4) has equally served as a research method especially during its exemplary application (chapter 4, article II), and much wider application in chapters 5 (article III).

Results of this study specifically for chapter 3, with regards to Fish Farming adoption, reveals that this kind of farming remains an attractive activity mostly for medium-scale farmers in Africa. However, for a sustained adoption of this innovation in SSA, there is the need of 1)

targeting support to medium-scale farmers, 2) improving organisational structures of farmers, 3) strengthening the fragile extension system, and, 4) improving research for fingerlings production.

For Conservation Agriculture (chapters 4 and 5), the study reveals the need to addressing the following critical concerns in any attempt towards sustainably promoting its adoption and wider uptake in SSA: a) competition and conflict over resources, b) market conditions for CA inputs and outputs, c) CA network and connectivity, d) type of communication channels, e) complexity of CA as a package & technical characteristics of CA as an innovation, g) limited acceptability of CA by young farmers, h) need for an enabling administrative and policy environment at village and regional levels and, i) the issue of land access, ownership and use.

As far as contributing to new methodological approaches in this field is concerned, a qualitative participatory and expert assessment approach (QAToCA) has been developed (chapter 4, article II). In spite of the noted limitations of the developed approach, its publication in peer reviewed scientific journals, presentation in international scientific conferences, and continuous use as a research tool in Africa makes it already a worldwide invention. QAToCA results 1) gives a picture of the relative adoption and diffusion potential of CA across SSA, 2) forms a basis for restitution and discussions with stakeholders of the various case studies, in providing new insights into the specific development and diffusion programs, 3) provide entry points for planning /adjusting some of the on-going and future promotion efforts, 4) provide a knowledge base towards the understanding of supporting and hindering factors for the adoption of innovations (especially CA) under specific; agro-ecological, socio-economic, institutional and cultural conditions of SSA.

Summarily, findings of this work suggest that in any effort towards improving the general environmental management practices of farmers, especially with regards to the introduction and adoption of new technologies or sustainable management practices, the issues of 1) market conditions for such technologies and 2) the general characteristics of such technologies as objects of adoption need to be carefully considered. In addition, there is a strong need for enabling political and institutional frame conditions especially at the village level in case study areas where sustainable management practices like Conservation Agriculture and Fish Farming are being introduced.

Zusammenfassung

Diese Doktorarbeit wurde in kumulativer Herangehensweise auf der Basis einer Reihe von wissenschaftlichen Veröffentlichungen erstellt. Das Erkenntnisinteresse lag dabei auf den Übernahme- und Diffusionsprozessen von Innovationen mit einem besonderen Schwerpunkt im Sektor Landwirtschaft. Mit dem Ziel, eine Querschnittsuntersuchung von Innovationen von Aquakultur über Getreideproduktion bis hin zu Bodenwissenschaften durchzuführen, sind in dieser Arbeit mit Fischzucht einerseits und Conservation Agriculture (CA) andererseits zwei Beispiele für landwirtschaftliche Innovationen in Afrika ausgewählt und untersucht worden. Auf das erste Kapitel (allgemeine Einführung), welches die generellen Ziele, das Forschungsdesign und die Struktur der Arbeit beschreibt, folgt das zweite Kapitel mit einer ausführlichen Literaturübersicht und Bewertung von ausgewählten Übernahmetheorien und Konzepten. Diese bilden für die folgenden Kapitel den konzeptionellen Rahmen. Die weiteren Kapitel entsprechen drei Peer-Review Artikeln und bilden den Kern der Arbeit. Dieser Teil beinhaltet: a) Kapitel 3 (Artikel I) mit einer Untersuchung von Übernahme- und Diffusionsprozessen in der Fischzucht in Kamerun, b) Kapitel 4 (Artikel II) mit der Darstellung von Entwicklung und exemplarischer Anwendung eines qualitativen fachspezifischen Bewertungsinstruments für die Übernahme von CA (QAToCA) in Afrika und c) Kapitel 5 (Artikel III), welcher die weiter gefasste Anwendung des QAToCA-Ansatzes beschreibt, um letztendlich das Übernahme- und Diffusionspotential von CA in fünf Fallstudien in Subsahara-Afrika zu bewerten.

Mit speziellem Fokus auf Fischzucht und CA als Beispiele für landwirtschaftliche Innovationen in Afrika, kann diese Arbeit 1) die in Teilen große Komplexität in der Realität der Übernahme und Diffusion landwirtschaftlicher Innovationen in Afrika aufzeigen, 2) das Wissen und Verständnis von solchen Kontextfaktoren vergrößern, die eine Übernahme und Diffusion von Innovationen in Afrika beeinflussen, und 3) zu einer Entwicklung eines neuen methodischen Ansatzes in diesem Forschungsfeld beitragen. Die empirische Betrachtung der Arbeit besteht, neben einer Literaturkritik bezüglich bestehender Theorien und Konzepte sowie der ausgewählten Fallbeispiele, vor allem aus verschieden Methoden des Participatory Rural Appraisal (PRA). Dazu gehören leitfadenorientierte Interviews mit Landwirten und Experten, Zielgruppendiskussionen, Interviews mit Schlüsselpersonen sowie teilnehmende Beobachtung. Der QAToCA-Ansatz, der als partizipative Bewertungsmethode in dieser Studie entwickelt wurde (Kapitel 4), hat gleichermaßen als Forschungsmethode gedient – vor

allem während der exemplarischen Anwendung in Kapitel 4 (Artikel II) – wie auch als Ansatz für eine breitere Anwendung in Kapitel 5 (Artikel III).

Die Ergebnisse dieser Studie, und insbesondere von Kapitel 3 hinsichtlich der Einführung von Fischzucht, machen deutlich, dass diese Art der Landwirtschaft hauptsächlich für mittelständige Landwirte in Afrika ein attraktives Betätigungsfeld bedeutet. Eine nachhaltige Übernahme solcher Innovationen in Subsahara-Afrika bedarf jedoch zunächst 1) einer zielgruppenorientierten Unterstützung für mittelständige Landwirte, 2) der Verbesserung der Organisationsstrukturen der Landwirte, 3) einer Stärkung des bislang fragilen Übernahmesystems sowie 4) verbesserte Forschung zur Junglachsproduktion.

Bezüglich CA (Kapitel 4 und 5) legt die Studie den Bedarf offen, sich kritisch mit den folgenden Themen hinsichtlich weiterer nachhaltiger Förderung von Verbreitung und Übernahme in Subsahara-Afrika auseinander zu setzen: a) Konkurrenz und Konflikte um Ressourcen, b) Marktverhältnisse für CA Inputs und Outputs, c) CA Netzwerk und Anschlussfähigkeit, d) Arten von Kommunikationskanälen, e) Komplexität von CA als Einheit sowie technische Charakteristika von CA als Innovation, g) begrenzte Akzeptanz von CA bei jungen Landwirten, h) Bedarf eines aktiven Verwaltungs- und Politikumfelds auf dörflicher und regionaler Ebene und i) das Problem von Zugänglichkeit, Besitz und Nutzung von Land.

Der in dieser Studie entwickelte methodische Ansatz erweitert damit die existierenden Forschungsmethoden auf diesem Gebiet um einen qualitativen partizipativen und expertenbasierten Bewertungsansatz QAToCA (Kapitel 4, Artikel II). Trotz der erwähnten Einschränkungen des entwickelten Ansatzes machen die wissenschaftlichen Publikation, Präsentationen auf internationalen wissenschaftlichen Konferenzen und die weitere Anwendung als Forschungswerkzeug in Afrika diesen Ansatz bereits zu einer weltweiten Erfindung. Die QAToCA Ergebnisse können damit 1) einen Überblick über das relative Übernahme- und Diffusionspotential von CA in Subsahara-Afrika geben, 2) eine Basis für die auswertung und Diskussion mit den Akteuren der verschiedenen Fallstudien bilden, indem sie neue Einblicke in die spezifischen Entwicklungs- und Diffusionsprogramme geben, 3) Einstiegsmöglichkeiten für Planung und Anpassung von bestehenden oder zukünftigen Bemühungen um Förderung bieten, und 4) eine Wissensbasis bereitstellen, um unterstützende, bzw. hinderliche Faktoren für die Übernahme von Innovationen (speziell CA)

zu verstehen, genauer gesagt für agrarökologische, sozio-ökonomische, institutionelle und kulturelle Bedingungen in Subsahara –Afrika.

In der Zusammenfassung lassen die Ergebnisse dieser Arbeit darauf schließen, dass 1) die Marktverhältnisse für solche Technologien und 2) die allgemeine Beschaffenheit solcher Technologien als Gegenstand der Einführung bei jeglichem Einsatz für eine Verbesserung der allgemeinen Praxis im Umweltmanagement der Landwirte, speziell im Hinblick auf die Einführung und Übernahme von neuen Technologien oder nachhaltigen Managementmethoden mit Bedacht berücksichtigt werden müssen. Zusätzlicher Bedarf besteht in der Unterstützung von politischen und institutionellen Rahmenbedingungen für die Übernahme von Innovationen speziell auf Dorfebene in Gebieten, die für neue Managementmethoden, wie Conservation Agriculture und Fischzucht, vorgesehen sind.

List of Publications

This dissertation is based on work contained in the following articles all indicated by Roman numbers within the text.

"Article I" - Chapter 3:

Ndah, H T; Knierim, A.; Ndambi, O. A. (2011): Fish
Farming in Cameroon: a field survey of determinants for farmers' adoption behaviour. - *The Journal of AgriculturalEducation and Extension*.17 (4): 309-323

"Article II" - Chapter 4:

Ndah, H. T. ; Schuler, J.; Uthes, S. ; Zander, P. ; Triomphe, B.; Mkomwa, S.; Corbeels, M. (2012): Adoption potential of Conservation Agriculture in Africa: a newly developed assessment approach (QAToCA) applied in Kenya and Tanzania. *Land Degradation and Development*.doi: 10.1002/Idr.2191,

"Article III" - Chapter 5:

Ndah, H.T.; Schuler, J.; Uthes, S.; Zander, P.;Traore, K.; Gama, M.S.; Nyagumbo, I.; Triomphe, B.; Corbeels, M. (2014): Adoption potential ofConservation Agriculture practices in Sub-Saharan Africa: results fr17 (3): 620-635om five case studies, *Environmental Management*. 17 (3): 620-635

Contribution to journal articles which form the core of this thesis

Article I: Chapter 3 - Original idea, literature survey and main author

I conceived the original idea for this article, after realising from the literature that most past studies on Fish Farming in Cameroon, failed to investigate issues related to the core attributes of adoption as identified by E.M. Rogers (2003). My motivation further came from the identified knowledge gap on the failure by previous studies to examine how the specific contextual driving and hindering factors collectively affect the adoption decision process of farmers. As the main author, I then carried out the survey and later drafted and shared the first draft for this article amongst the co-authors. Throughout the writing process, I did most of the writing and coordination work by guiding the co-authors through the iteration exchange process as they read the draft, adding text and making suggestions for improvement and which all eventually led to the publishing of the article.

Article II: Chapter 4 - Original idea, literature survey and main author

As part of an EU FP7 funded project CA2Africa (wwww.ca2africa.eu), I conceived the first idea for this article after recognising a knowledge gap in the literature with regards to most past studies that have advanced reasons for the low adoption rates of CA in Africa. Most of these studies were seen to have failed to address the characteristics of CA as an object of adoption and as an emerging innovation with corresponding effect on its adoption potential. Contextual factors influencing CA adoption were seen not to have received the proper attention needed and as well, there was a complete absence of a comprehensive self-assessment tool which could systematically evaluate factors influencing CA adoption at the farm, village and regional scales. These knowledge gaps triggered my drafting of the very first draft of the tool which has formed the basis of this article. Together with project partners who have eventually ended up as co-authors for this article, the testing of the tool was done followed by the field survey. From the start, I did most of the writing of the first draft, and then shared with co-authors who made suggestions for improvements.

Article III: Chapter 5 - Original idea, literature survey and main author

After developing and publishing the tool (QAToCA) for the assessment of CA adoption in Africa (article II), I felt the need to further test its suitability by applying it in other case studies across SSA. This led to the initial idea for this article which is focused on the

application of QAToCA in SSA; specifically in five case studies across Zambia, Malawi, Zambia, Southern and Northern Burkina Faso. Like in the case of article II, data for the case of Zambia was obtained during my field visit in 2011 while that from other case studies came from a collaborative field survey with CA2Africa project partners based in the various case study areas. After the survey, I proceeded in writing the first draft for the articles, and then later shared with co-authors who made further suggestions for improvement.

CHAPTER 1

GENERAL INTRODUCTION

1. Chapter 1: General introduction

1.1 Background and Objectives

Adoption is seen as the first or minimal level of behavioural utilization while diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers 2003). Rogers (2003) provided a framework for studies on why innovations do not usually disseminate faster as expected and what factors determine its pace. Today, it is widely accepted that the replication of good agricultural practices involve high cost and this hinders poor people from benefiting from such practices (Bringe et al. 2006). Recent studies (Bringe et al. 2006) have further stressed the importance of scaling up (diffusion) and its general role in the overall adoption process. Oudenhoven and Wazir(1998)in: Bringe et al. (2006) confirm this need by stating that *"Practitioners, policy makers, researchers, and funding agencies would agree that there issufficient knowledge and experience to address most problems (...). The assignment,therefore, is not so much to improve the "state-of-the-art", but rather to lift up the "state of practice" so that an ever increasing number can benefit. (...) It makes sense onpragmatic and economic grounds to replicate what has proven to be working rather thanreinventing the wheel..."*

In spite of this awareness, over the years most innovations in the field of agriculture have fallen short of wide scale adoption and diffusion especially in Africa. Though much exists in the literature explaining the adoption processes of agricultural innovations, reasons for their slow adoption and diffusion rates in Africa are still not clearly obvious.

Most studies have acknowledged that the adoption potential of agricultural innovations in Africa are site-specific and depends on the local biophysical, socio-economic and cultural environment which needs to be given special consideration in any attempt to identify constrains to adoption (Erenstein 2002; Giller et al. 2006). Emphasis is as well made on the need for a critical assessment under which ecological and socio-economic conditions - introduced new innovations are best suited for smallholder farming in Africa (Giller et al. 2006) and for its regional potential for scaling up. In looking at best possible options to identify general constrains to the adoptions of innovations, Sumberg (2005) calls for a distinction between constraining variables that are endogenous to the fit between an innovation and a specified group of potential users, and those that are exogenous and act as prerequisite conditions. Siebert et al. (2006) further call for the importance of viewing

adoption of agricultural innovations not in a static sense (this is, as a situation determined by one or several influencing factors) but rather as a process marked by interaction. The study goes further to emphasise that financial compensation and incentives function might act as a necessary factor towards farmers acceptance of new innovations, but this alone is clearly not sufficient to draw conclusions with regards to farmers adoption decision process.

The outlined literature all insinuate one thing: that there is an intricate interaction of contingencies affected by locality and specific context, such as: agronomic, economic, socio-cultural, institutional and psychological factors within the adoption and diffusion process of innovations (Siebert et al. 2006). Each of these factors therefore plays interwoven roles in each national, regional and specific farm context of the region. To this effect, the willingness and ability of farmers to co-operate in the adoption process is not reducible to the location of their holding nor to their attitudes or values towards such categories as 'nature' or 'authority'; and neither is their co-operation a simple function of economic factors but a combined action of all (Siebert et al. 2006).

Focusing on Fish Farming and Conservation Agriculture (CA) as examples of agricultural innovations in Africa therefore, this study makes use of established theories and concepts : 1) to partly demonstrate that, the reality of adoption and diffusion of these two forms of agricultural innovations in Africa is a much more complex issue, 2) to improve on the knowledge and understanding of the adoption and diffusion of both Fish Farming and CA innovations in selected case studies across Sub Saharan Africa and, 3) to develop and contribute to a new methodological approach in this field of study. In this PhD project, these objectives have been logically addressed and achieved through a collection of peer reviewed journal articles as follows:

1) Assessing the adoption of Fish Farming in Cameroon: A field survey of determinants for farmers' adoption behaviour (article I)
2) Developing a tool for assessing the adoption potential of Conservation Agriculture in Africa: exemplary application in Kenya and Tanzania (article II)
3) Assessing the adoption potential of Conservation Agriculture practices in Sub-Saharan Africa: results from case studies spread across Zambia, Burkina Faso, Malawi, and Zimbabwe (article III)

Results of this study 1) give a picture of the relative adoption and diffusion potential of these two innovations across Africa, 2) form a knowledge base for restitutions and discussions with

stakeholders of the various case studies, in providing new insights into the specific development and diffusion programs and, 3) provide entry points for planning /adjusting some of the on-going and future promotion efforts of these two agricultural innovations in SSA.

1.2 Selected agricultural innovations - in Africa

In the course of my Master degree studies (MSc) - Agricultural Sciences, Food Security and Natural Resource Management - I had the chance to study a range of courses cutting across aquaculture, crop production, food security and natural resource management. Because of a strong commitment to issues of poverty alleviation and rural development, I gradually developed particular interest on innovations systems especially in the field of agriculture. The choice of studying Fish Farming and Conservation Agriculture for this PhD therefore was driven by the quest to have a representation picture of adoption and diffusion of agricultural innovations in Africa cutting across: Aquaculture, Crop production and Soils. My target was to select forms of innovations from these fields recognised to have a potential positive impact over the welfare and livelihood of small holder framers in Africa and where this impact has not been fully achieved due to lack of adoption. Coincidentally, access to funding through projects promoting these two innovations only helped in consolidating my decision. The main goal is on assessing the adoption and diffusion of these two innovations as examples of Agricultural innovations in Africa.

1.2.1 Conservation Agriculture (CA)

Conservation Agriculture (CA) is increasingly promoted in Africa as an alternative for coping with the need to increase food production on the basis of more sustainable farming practices. CA is specifically seen as a way to address the problems of soil degradation resulting from agricultural practices that deplete the organic matter and nutrient content of the soil. It aims at higher crop

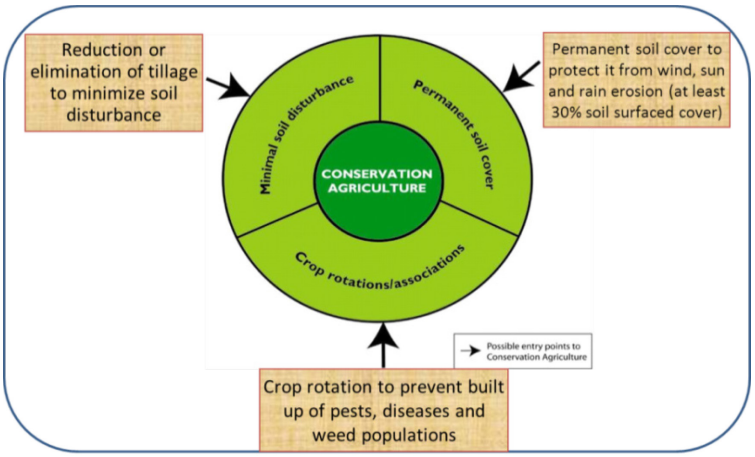


Figure 1: Three principles of Conservation Agriculture

Adapted from Calgeri and Ashburner, 2006

yields and lower production costs and is based on three principles which are believed to enhance biological processes above and below the ground. These are: (1) minimum or no mechanical soil disturbance; (2) permanent organic soil cover (consisting of a growing crop or a dead mulch of crop residues); and (3) diversified crop rotations (Derpsch et al. 2010)(Figure 1).

In spite of the well known benefits which come along with practising CA, its rate of adoption in Africa over the past years has remained low. This work specifically examines the adoption and diffusion processes of CA in Africa with special emphasis on selected case studies spreading across Kenya, Tanzania, Burkina Faso, Malawi, Zambia and Zimbabwe –see Ndah (2011) and Ndah (2012) i.e. articles I and II, chapter 4 and 5 respectively.

1.2.2 Fish Farming

Aquaculture refers to "farming aquatic organisms". This includes: fish, crustaceans, molluscs and aquatic plants. Among the many aquatic organisms, fish occupies a major percentage. The cultivation of fish either in lakes, rivers, seashores, damps and ponds, etc., is therefore generally referred to as Fish Farming. This work focuses on pond fish cultivation as an example of agricultural innovation in Africa. For convenience, in most parts of the work, the term Fish Farming is mostly used referring not to the general meaning of it 'per se' but specifically to the cultivation of fish in small earthen ponds.

Fish Farming as a major component of Aquaculture in Africa has come a long way since it was first introduced (Jamu and Ayinla 2003). However, despite steady growth, realizing the potential of aquaculture on Africa's suitable lands has been elusive (Brummett et al. 2008).

In comparison to the rest of the continents, Fish Farming production in Africa is still insignificant at global level and accounted for about 0.9% (404.571t) of the total global fish production in 2000 (FAO 2004).Shortcomings to the adoption and diffusion of Fish Farming in the African continent are not only glaring at the continental level but equally within countries. As a part of this project, this work specifically addresses the adoption and diffusion process of Fish Framing as an example of agricultural innovation with emphasis on the case of Cameroon located in western Africa (see article I chapter 3)

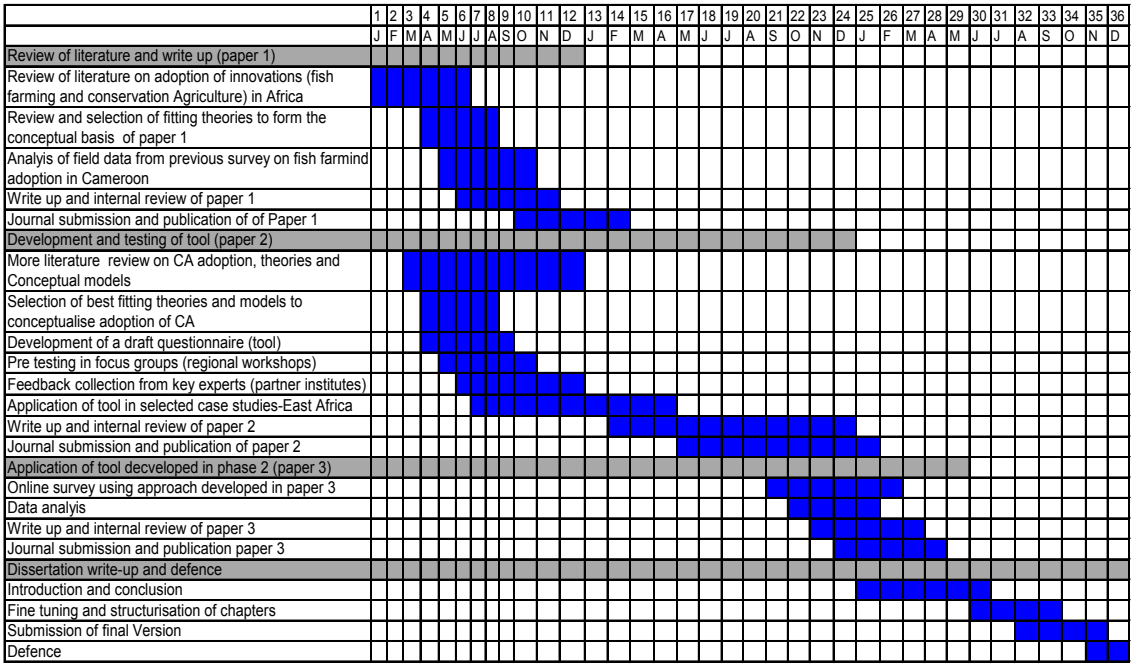
1.3 Project design and implementation

1.3.1 Review phase

The work place for this phase was mainly at the Leibniz Centre for Agricultural Landscape Research (ZALF Müncheberg). Being the first phase of the project, this phase gave room for a detailed and concise review of documented secondary data on the two forms of agricultural innovations focused on within this study (Table 1). A broad screening of what was relevant and available for the work was carried out. Unavailable data was obtained through inter-library services of ZALF.

In preparation for the field survey, a network was established with the regional partners in Africa both for the case of Fish Farming and CA innovations. This network was later used for the survey (e.g. case of Fish Farming, article I – chapter 3) or pre-testing and application of the Qualitative tool developed within this study (e.g. case of CA, article II – chapter 4). Furthermore, establishing a relationship of mutual trust with the stakeholders as well as rapport formation and general networking formed the main activities at this phase. The study methodology was further revisited, amended and adjusted depending on the field situation.

Table 1: Project phases and scientific publication



1.3.2 Field survey, tool development, testing and application phase

This phase equally cut across the three articles and involved a series of iterative processes making use of both Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) methods.

For instance, semi structure interviews, focused group discussions, expert interviews and key informant interviewers were extensively dealt with to attain the objectives for article I and II (chapter 3 and 4 respectively). This applied same for article III (chapter 5) where the developed Qualitative expert Assessment Tool (QAToCA) was applied in multi-shareholders workers (focused groups) across the selected case studies in SSA.

1.3.3 Analysis, write up, publication phase

Because of the cumulative nature of the study, this phase had to run parallel with the other phases (Table 1).The main focus here was finding best approaches for analysing and presenting the collected data in form of peer reviewed articles which have eventually formed the core of this work. It was expected that "article I" (chapter 3) be published by month 14, article II (chapter 4) by month 24 and article III (chapter 4) by month 28. In parallel within this period, the author was equally involved in a series of training courses (Table 2), presentation of articles and posters in conferences, seminars and workshops (see section 9.3 and 9.4: *list of conference proceedings and international presentations*) which all assisted in

enriching this study. Furthermore, regular supervisory visits (professors) and collaboration with mentors for guidance and advice equally took place under this phase.

Table 2: Further training during the PhD period

Academic Institution	Course/module title or name	Module acronym or registration number	Responsible person	Grade obtained	ECLS credits
HU-Berlin	Participatory Agricultural Knowledge System	PAKS	Dr. Thomas Aenis	A	06
HU-Berlin	Participatory Research Methods	PRAM 20229	Dr. Andrea Knierim	A+	06
ZALF, Müncheberg	Methods in Landscape Analysis; Zalf thought module 1	Extern	Dr. Stefan Wirth	B	06
ZALF, Müncheberg	Intensive Training on publishing in Peer Review journals	Extern	Dr Gunter Tress and Barbel Tress	-	03
ZALF, Müncheberg	Intensive Training on Coping with the challenges of a PhD	Extern	Dr Barbel Tress	-	02
Total ECLTS credits obtained					**23**

1.3.4 Dissertation write-up and defence

This formed the final phase and involved a gradual compilation of the peer reviewed articles to form the final thesis. The articles have been structured in form of chapters to form the main part of the project. An introduction, theoretical background and conclusion have been added and logically linked to form a complete thesis report. Parallel to this phase, the student undertook further training in form of course work at both the University and Research institute equivalent to 23 ECLTS credit points. This further strengthened his scientific background in this field of study (see Table 2).

CHAPTER 2

CONCEPTUAL BACKGROUND, SYNTHESIS OF METHODS AND BRIDGE TO JOURNAL ARTICLES

2 Chapter 2: Conceptual background, methods and bridge to articles

2.1 Introduction

In accordance with Esser (1999), cited in Sattler and Nagle (1997) acceptance or adoption is the result of an interrelated decision making process depending on *Subject of acceptance* (the farmer), the *Object of acceptance* (e.g. a conservation measure such as CA), and the *surrounding context* or frame conditions (Lundvall 2004; World Bank 2006). Prager (2002) in the same light states that the rate of adoption of an innovation depends on three main characteristics: firstly, the characteristics of the innovation in question, secondly, the individual farmer as a potential adopter of the innovation, and thirdly, the frame conditions such as the financial situation of the farm, the specific climatic and regional site conditions or the general legal restrictions and policy settings. The theoretical background chosen for this study therefore revolves around these considerations to assess the adoption and diffusion processes of Fish Farming and Conservation Agriculture as examples of agricultural innovations in Africa (Figure 2).

Because there are numerous interdependencies explaining the adoption decision process of a farmer, it is important to clarify and prioritize the opportunities and threats for further adoption as well as understand innovation processes related to both Fish Farming and CA systems. To do this in a systematic and logical manner, this project, first started by reviewing adoption theories and concepts of innovations system which captures specifically the above consideration within an adoption decision making process. The frameworks were then related to both Fish Farming and CA systems exposing and identifying existing knowledge gaps. Specific relevant knowledge from these theories and concepts were translated to a set of semi-structure questionnaire used for the field survey which has formed the basis in meeting the objectives of "article I" for this work (see chapter 3). Alongside further review and a series of iterative processes with stakeholders, the questionnaire as well as reviewed theories and concepts was further expanded to form a checklist.

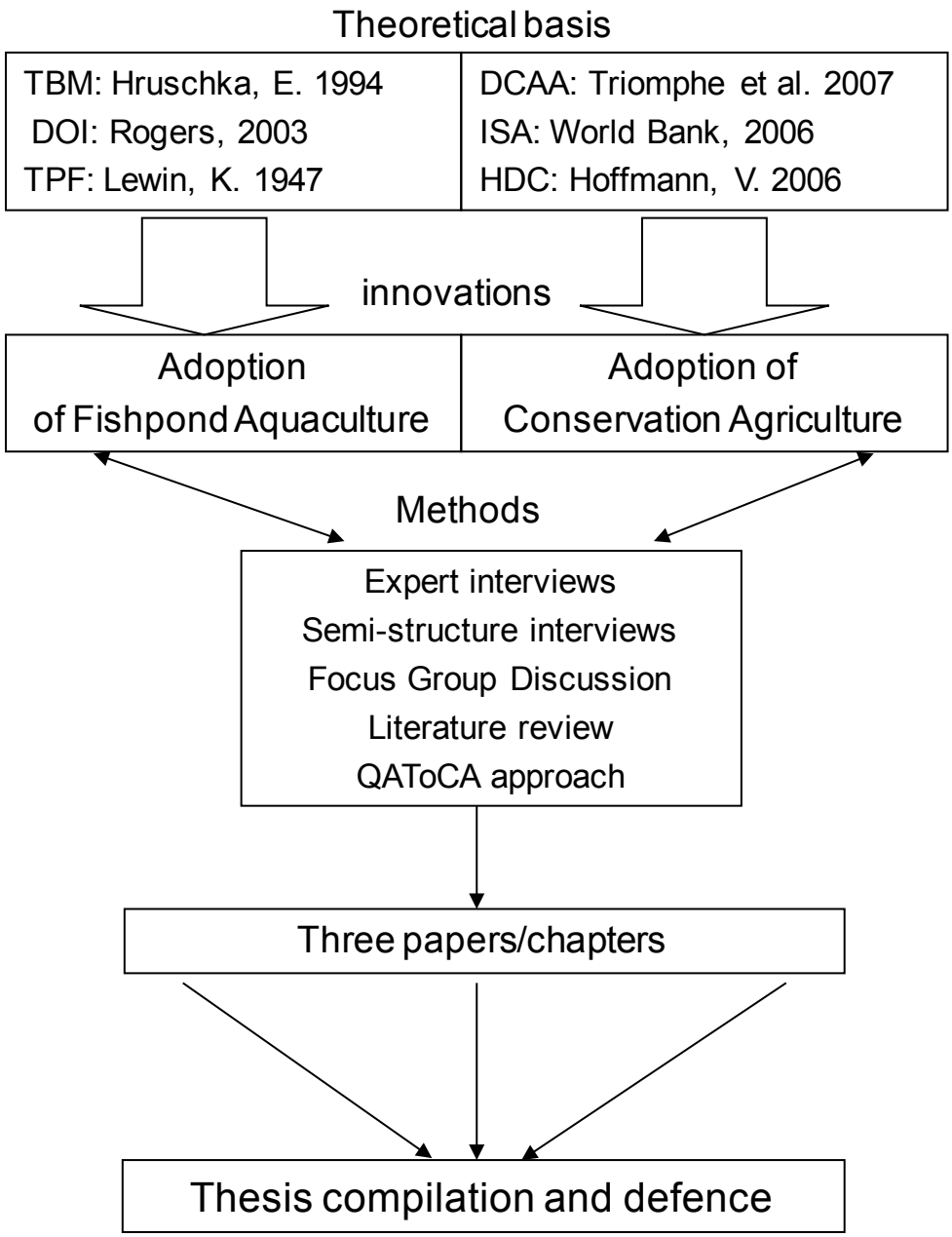


Figure 2: Structure of PhD project

Based on this checklist and further iteration processes with stakeholders, the Qualitative expert tool for assessing the adoption potential of CA in Africa has been developed, tested and applied in Kenya and Tanzania (see chapter 4 article II). A further application of this tool in Southern and Western Africa has led to article III of this work (chapter 5). In the following paragraphs, the selected reviewed theories and concepts, collectively used as frameworks in different parts of this project are presented exposing their respective strengths and limitations in the conceptualisation process of adoption decision making process. [For a *brief description and graphical illustration of each of these theories or concepts, see Appendix of this thesis*].

2.1.1 Theory of Psychological Field

Lewin (1943) with this theory states that human behaviour is seen as a result of the interplay of diverse forces that create a set of circumstances through the dynamic interaction of man and his environment.

According to Lewin (1943), the interaction of situational forces with the perceived environment can be described as a field of forces, a system in tension or a psychological field. Human behaviour can be described as follows: A person (P) in his subjectively perceived environment feels something is worth striving for; he then mobilizes his personal powers to achieve this goal.

b = f (P, Esubj.)
Where;
behaviour (b) is a function of an individual's subjectively perceived environment (P, Esubj.)

When something negative or undesirable occurs, he activates his personal powers in the same way to avoid the negative situation. Ways of reaching targets and avoiding negative situations can be blocked or impeded by barriers or inhibiting forces (for instance; lack of knowledge, uncertainty about outcome, insufficient capital, cultural practices, lack of opportunities for scaling etc.).

Summary implication and critical assessment of Lewin's theory towards the adoption decision process of agricultural innovations in Africa

Relating this theory to farmers' adoption of innovations, behaviour can be likened to their adoption behaviour towards each of these innovations e.g. Fish Farming or CA. It is therefore a function of each specific farmer and his psychological state as well as his subjectively perceived environment (adoption context). To understand behaviour towards CA or Fish Farming in Africa, it is vital to examine the perceived opportunities and threats found within the psychological field of the respective farmers which are all influential to their adoption behaviour. It is as well important to examine these forces from the perspective of the farmers if the objective is to achieve a sustained adoption beyond the promotion phase. This is done using situation analysis which helps capture the opinion of the target group and their subjective perception towards the respective innovation e.g. CA or Fish Farming. Nevertheless, this assumes that the farmer has the sole influence over his adoption decision

making process. The theory fails to consider cases where farmers might be forced to adopt innovations based on the institutional or policy frame conditions or following the sudden occurrence of natural disasters (floods, storm) as well as severe impact of global change episodes (e.g. Climate change, market trends, etc.). Under such conditions, farmers are left with no choice than to basically adopt certain innovations even if this clashes with their subjective perception as suggested by Lewin (1943), - though such adoption might be short-lived.

2.1.2 Theory of Behaviour Modification

Following Hruschka (1994), the theory refers to those forces conducive or facilitating the goal or target attainment as Driving forces (DF) while those negatively influential to target attainment he calls them Inhibiting forces (IF). Inhibiting forces for technology adoption (e.g. CA or Fish Farming) might include for instance, lack of subsidies, limited liquidity (for labour hiring, buying herbicide, seeds of legumes for soil coverage, etc.), lack of machinery, and limited knowledge. On the other hand, driving forces or forces conducive to positive target might include, for example, financial assistance, technical advice, training, provision of inputs, linkage with market outlets, etc. Like Lewin (1943), Hruschka (1994)confirmed that behaviour (in this case adoption) results from the psychological field of inhibiting and driving forces. These forces are therefore always present in a state of equilibrium or dis-equilibrium with varying degrees of tension between them. According to Hruschka (1994)an existing state of equilibrium can be changed (for instance, from conventional farming to CA) or from crop farming to Fish Farming by:

- the introduction of driving forces
- the removal of inhibiting forces or
- Combining these two processes

This implies*:*

CB=+DF-IF

Where: CB=Change in Behaviour

DF=Driving Forces

IF=Inhibiting Forces

Once such forces are identified in the farmers' decision making process, the chances of diffusion can be estimated and consequences for promotion programs can be concluded (Hoffmann 2005; Rogers 2003).

Summary implication and critical assessment of Hruschka's theory towards the adoption decision process of agricultural innovations in Africa

Situating this in the context of CA and Fish Farming promotion in Africa, the theory conceptualizes the likely picture of farmers' change in behaviour from conventional farming to CA or from Crop production to Fish Farming. A farmer practising conventional farming in Africa is assumed to be at a state of equilibrium implying the driving and negative forces to his practice are equal. For such a farmer to adopt CA farming this will imply a change in behaviour hence the old state of equilibrium needs to be disturbed. Possible observed benefits that CA farmers enjoy by practising CA such as increase yields; labour savings, etc., are the driving forces to encourage a disturbance of this equilibrium on the side of potential adopters. On the other hand, lack of CA knowledge, cost of CA machineries, seeds, etc., in Africa are some of the inhibiting forces that might work against this change. With regards to Crop farmers, lack of fertile land for a particular farmer in possession of a swampy area suitable for Fish Farming can be seen as a driving factor for adopting Fish Farming and Vice Versa. Like Lewin (1943), for promotion of agricultural innovations in Africa to be effective, it is but vital to carefully identify these influential forces for every specific innovation and to design measures in re-enforcing the driving forces as well as removing those forces considered to be performing inhibiting roles. However, same as Lewin (1947), Hruschka makes too much generalisation on the issue of driving and hindering forces without specifically categorising them under environmental, institutional, policy, individual or characteristics of the innovation involved as is often the case in reality.

2.1.3 Diffusion of Innovation Theory

As suggested by Rogers (2003), empirical studies have shown that there is usually a typical "S" shape for the diffusion curve when innovations establish themselves in a social system; According to Hoffmann (2005) at the onset, adoption rate is low; it then rises gradually and falls again towards the end. But sometimes at the beginning, adoption is particularly hesitant and accelerates increasingly only in the final phase; this gives rise to a "J" shaped curve (See Appendix). Rogers (2003) uses the concept of individual innovativeness theory to explain who adopts an innovation and when. He therefore illustrates this with a bell-shaped curve depicting the following categories of adopters:

- The first category is called "*innovators"* (2.5%). These are the *risk-takers* and pioneers who lead the way. They are the venturesome and educated persons in the society.

- The second group is the "*early adopters"* (13.5%). They climb on board the train early and help spread the word about the innovation to others. They include the social leaders, most popular and educated persons in the society.

- The third group is the "*early majority"*. They constitute 34% of the potential adopting population. The innovators and early adopters convince the early majority and gives assurance on sustainability of the innovation. The people in this group are those who make a deliberate attempt to adopt the innovation and have acquired information through the many informal social contacts at their disposal.

- The fourth group is the "*late majority"*. This group as well constitutes 34% of the potential adopting population. Adopters here wait to make sure that the innovation is in their best interests. These are the individuals who are highly sceptical and resist adopting until absolutely necessary.

- The final group is the "*laggards"* (16%). Like the late majority, members of this group are highly sceptical and in many cases, they never adopt the innovation. Those that fall in this category include the traditional, lower social class in the society (Rogers 2003).

In addition to the above diffusion theory, Rogers (2003) further identified a certain number of characteristic determinants that render an innovation more or less apt for easy adoption as follows:

Perceived attributes

- ***Comparative advantage*** is the degree to which an innovation (CA) is perceived better than the idea it supersedes (Conventional agriculture). It is positively related to its rate of adoption. For instance, the rate of adoption of CA will be high if the target groups of adopters perceive it has significant advantages over conventional farming and other practices in their vicinity.
- ***Complexity*** is the degree to which an innovation (CA) is perceived as relatively difficult to understand and to use. The complexity of an innovation (CA) as perceived by members of a social system is negatively related to its rate of adoption.

- ***Trialability***is the degree to which an innovation (CA) may be experimented at a limited basis (field level) or adopted in stages (zero or minimum tillage; crop rotation; mulching, one at a time). The higher the trialability, the higher the chances of adoption.
- ***Observability*** is the degree to which observers are able to see the results of an innovation (CA). The higher the observability, the higher the adoption rate. If CA increases yields visibly (or decreases costs visibly, such as by saving labour), then there is a high possibility that it will be adopted.
- ***Compatibility;*** this is the degree to which an innovation (CA) is perceived as consistent with the existing values, past experience and needs of potential adopters. The more the innovation is compatible, the higher the chances of adoption.

Type of innovation decision

The innovation decision process is the process through which an individual (or other decision making unit) passes from first knowledge of an innovation to forming an attitude towards the innovation. Such an attitude can be reflected in a decision either to adopt or to reject the innovation. This can be either optional from the point of an individual farmer, collective from a group of farmers or is forced by the authority to do so.

Communication Channels/Scaling up strategy

This is the means by which a message moves from source to receiver. Communication is categorized as either interpersonal or mass media in nature and as originating from a specific or diverse source. The more diverse the source of information is, the faster the rate of adoption. For instance, use of mass media and other diverse means of disseminating CA knowledge through social groups and denominations will have a better chance of adoption in Africa rather than relying solely on interpersonal communication between individual farmers.

Social system: norms, network interconnectedness

These are the socio-cultural practices and norms within the village and community level, the interconnectedness of the various actors in the CA innovation system (network) at village, regional levels and beyond which can be influential to the rate of adoption. For instance, collectivism, land tenure ship and accessibility are all factors that influence the rate of CA adoption depending on how they are handled within the various communities and regions

across Africa. The higher the interconnectedness of a group of adopters, the higher the chances of diffusion, and vice versa.

Promotion efforts

This refers to the past and present efforts made to promote the innovation by the parties involved. This can be national as well as international bodies. Looking at the CA system in Africa, this will refer to all the institutions at national, regional and international levels involved in the research and promotion of CA practice.

With specific reference to CA as an object of adoption, in Africa some of the above attributes (characteristics) might have a detrimental role to play in its adoption decision process. Though CA is considered a single innovation, its perception in line with some of the listed attributes might vary with the varied and heterogeneous categories of adopters under the different socio-economic and cultural regions across the region.

Summary implication and critical assessment of Rogers's theory towards the adoption decision process of agricultural innovations in Africa

Relating this theory to CA or Fish Farming promotion in Africa, it helps to visualize the entry points for a population of potential adopters and the diverse reactions of farmers' vis-à-vis the technology. It also follows from applying Rogers's model that technology adoption in Africa can be hesitant from the start to finally accelerate at the final stage or it can rise slowly and fall again towards the final phase. Roger's model helps to clarify the fact that not all potential farmers can adopt innovations at the same time as well as not every member of the society might even find some innovations worth adopting. While some farmers will find e.g. CA in Africa attractive to them at different stages in the course of the diffusion process with varied reasons responsible for their behaviour, some will eventually find it not completely attractive at all and as such hang on to old traditional farming practice at all cost no matter the magnitude of promotion efforts put in place. Nevertheless, the above theory so far only consider; (1) the role of individuals, (2) does tend to focus on attitudes (such as lead farmers), without considerations for farm's structure and constraints, (3) considers an innovation (e.g. CA or Fish Farming) as a fixed technology, and not an emerging one.

2.1.4 Hohenheim Diffusion Concept

Similar to Rogers(2003), Hoffmann (2005) in this concept adds more value by examining the diffusion phases as well as characteristics of adopters who fall in the various phases of diffusion as follows:

I. **The innovator as a troublemaker**: The first person to practise an innovation in a social system is called an innovator (Hoffmann 2005). Hoffmann (2006) further qualifies the innovator at this early stage as one who experiences a problem for which he will like to find a solution. Again, his activity is not only seen as strange, but an indication that their methods are old fashioned and outdated. The people then put up their defence mechanism rejecting the innovation and the innovator and regarding him as a troublemaker (2005).

II. **The critical phase:** While Rogers (2003) terms the second category of adopters the early adopters, Hoffmann (2006) adds to this by terming this phase "*the critical phase*". He stresses that not everybody reacts negatively to the innovator (for instance, CA promoters).Some either because of their closeness to him as friends, relatives, etc., keep contact and refrain their mistrust and rejection. Some see themselves in a comparable situation with the innovator" *Available data show that the diffusion process sustains itself with no further need of support when about 10 to 20% of potential adopters have taken up the innovation*" (Rogers 2003).

III. **Transition to self-sustaining process**: At this phase, what is currently new is going to be the future norm. While the first few adopters make the activity attractive, adoption by influential persons bring in a new dynamism into the process. A deviant behaviour on the part of the innovator as initially regarded is now felt to be a new approach. At this stage, farmers may no longer adequately check whether the innovation is beneficial or not hence there is increased risk of misguided adoption of the innovation. This phase is synonymous to the *early majority* category mentioned by Rogers (2003) as composed of deliberate adopters of the introduced innovation.

IV. **Final phase of the wave:** While Rogers (2003) separates this group in his theory to *Late majority* and *Laggards*, Hoffmann (2005) simply term the two categories as the *Final phaseof the wave*. He mentions that if the innovation is assumed not to be equally appropriate and advantageous for all concerned, the adoption rate sinks slowly and gradually after reaching the peak. Just as the innovator from the onset was closest to the

innovation and the first to adopt, there are now people for whom inhibiting forces are far stronger than the driving forces.

It is assumed therefore that all potential adopters, if classified according to their pattern of psychological forces in relation to the decision on adoption, like in Rogers (2003), this will form approximately a normal distribution but with *four phases* in the diffusion process as opposed to *five phases* in the case of Rogers (2003). This has similarities with the phases of an innovation process and scaling-up such as those proposed by the EU IN-Sight project (www.insightproject.net).

Summary implication and critical assessment of Hoffmann's concept towards the adoption decision process of agricultural innovations in Africa

In the context of Africa therefore, Hoffman's model calls for paying attention to the possibility that agricultural innovators may face social rejection in some communities. It can equally be used as a diagnostic framework to assess those who first try out an innovation in a farming community. It could equally be used to check if this conforms to his hypothesis - that the very first adopters are often those closest to the innovators, later join by those who find themselves in comparable situations? This concept also calls attention to the eventual existence of specific measures taken by promoters of agricultural innovations in Africa to always reinforce the confidence of the innovators through outside contacts once they start facing social rejection from within their communities. Nevertheless, a key weakness to this concept is that Hoffmann focuses his attention mostly on individuals, whereas most "constructionist" theories refer to overall networks and institutions as structures influencing the spread of innovations.

2.1.5 Theory of Planned Behaviour

According to Ajzen (1991), this theory helps to understand how an individual behaviour (in this case adoption decision) can be altered. The theory can be used to predict deliberate behaviour, because behaviour can be deliberate and planned. It stems from the discovery that behaviour appears not to be 100% voluntary and under control. According to the theory, human action is guided by three kinds of considerations:

- Behavioural Beliefs: beliefs about the likely consequences of the behaviour (e.g. consequence of adoption of CA or Fish Farming)

- Normative Beliefs: beliefs about the normative expectations of others (e.g. expectation of researchers, policy makers, and promoting organizations on farmers adoption of CA of Fish Farming)
- Control Beliefs: beliefs about the presence of factors that may facilitate or impede performance of the behaviour-adoption (e.g. driving and inhibiting factors to the adoption of CA or Fish Farming).

Ajzen's three considerations are crucial in circumstances such as CA promotion when trying to change behaviour or attitude towards a practice (e.g. CA or Fish Farming). In their respective aggregates, behavioural beliefs, normative beliefs, and control beliefs in combination lead to the formation of a behavioural intention which ends up with a favourable or non-favourable behaviour. As a general rule, the more favourable the behavioural beliefs which lead to attitude, the normative belief which lead to subjective norm and the control beliefs which lead to perceived control, the stronger should be the person's intention to perform a behaviour (see graph in Appendix).

Summary implication and critical assessment of Adjzen's theory towards the adoption decision process of agricultural innovations in Africa

The theory can help in conceptualizing the situation of CA or Fish Farming promotion in Africa. For CA adoption to take place, for instance, farmers will always consider what gains and trade-offs are there in adopting it, what expectations are there for them from the side of promoting organizations, neighbours, friends and relatives, and lastly which opportunities and threats are in place that could influence their adoption behaviour. It is therefore vital to understand these self-reflexive scenarios that individual farmers undergo before finally making the decision to adopt or not. Such a conceptualization beforehand can provide indicators to which assisting mechanisms can be designed to better help the farmer in his adoption decision process. Nevertheless, like the case of Hoffmann above, the theory is limited to the role of individual (farmer's) behaviour leaving out the influence of networks and institutions in the adoption decision making process.

2.1.6 Dynamics of CA Adoption

Specifically refering to CA farming, Triomphe et al. (2007)states, "*usually farmers who are willing to follow the path to a more sustainable agriculture, embark on a long journey that takes them several years or even longer"*. This journey is assumed to consist of consecutive

phases, each characterized by use of specific practices that increasingly incorporate practice and mastery of the three principles CA (minimum tillage, rotation, permanent soil cover)(Triomphe et al 2007). He further emphasises that no journey towards adoption appears to be linear, and no journey seems to comprise the same sequence of phases, although some paths are more commonly followed than others. The authors illustrate their model with a graphical representation of four archetypes representing possible journeys, (see Appendix) from a hypothesized entry point (current farmer practice) to a hypothetical end point (CA practice of some kind) as a function of time.

Summary implication and critical assessment of Triomphe's concept towards the adoption decision process of agricultural innovations in Africa

Contrary to other models, who adopts an innovation, to what degree and why, is not specified in Triomphe et al (2007) graphic illustration. Another major difference of this theory, with that of Rogers (2003) or Hoffman (2006) is that an innovation is not assumed to be fixed, but on the contrary changes over time. In addition, the authors do not consider that there is necessarily one unique desirable target or end point in terms of technology adoption in Africa e.g. CA. Nevertheless, a major weakness of this concept is that there is no reference made to the "enabling environment', nor to the "individual factors" influencing adoption of innovation.

2.1.7 Innovation Systems Approach

The World Bank (2006) defines an innovation system as a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behaviour and performance. An innovation system involves the interaction of individuals and organizations possessing different types of knowledge and resources within a particular social, political, policy, economic, and institutional context (World Bank 2006). It involves different actors and institutions working in dynamic interaction, all contributing to the development of different dimensions of a given innovation: technologies, institutional arrangements and policies.

According to the World Bank (2006) the perspective of the innovation systems concept recognizes the importance of research activities but gives more attention to (1) the interaction between research and related economic actors, (2) the attitudes and practices that promote

interaction among actors and the learning that accompanies it, and (3) the creation of an enabling environment that encourages interaction and helps to put knowledge into socially and economically productive use.

Summary implication and critical assessment of World Bank's concept towards the adoption decision process of agricultural innovations in Africa

In effect, innovation system's approach adopts a holistic view of the adoption decision making process of farmers. It takes into cognisance, the various actors and linkages involved in this network as opposed to the linear approach of most adoption theories whose analysis narrowly consider only the individual adopter, the technology and the promoter. Adoption of innovations under this concept is regarded as a collective and continuous development process. The appeal of this concept applied to the understanding of adoption of agricultural innovations is that it allows for identifying which stakeholders, coordinating mechanisms, policies or components are lacking (diagnostic) or may be needed (recommendation) in the innovations development and adoption processes to overcome bottlenecks and constraints and to generate the needed knowledge, technologies or institutional arrangements (Corbeels et al 2009). Nevertheless, under this wider concept the specific role, and subjective perception of individual farmers become less visible hence small scale farmers in the wider adoption decision process can easily be neglected.

2.1.8 Summary outcome of reviewed theories and concepts

Though these selected theories and concepts all provide frameworks with potentials to studying the adoption processes of Fish Farming and CA, each theory or concept has its strength as well as limitations in conceptualising either the Fish Farming or CA system (Table 3). This has mostly to do with the specific angle/dimensions each of them addresses, which is for most of them only one of the many necessary angles which makes the inherent complexity of the whole issue of adoption and diffusion process of innovations. For example, while some theories/concepts focus mostly on individuals and factors affecting their behaviour, ignoring the more institutional ones, others suffer from the opposite problem: focus on institutions and policies, but overlook the individual dimensions. What each theory/concept brings to the overall framework in terms of levels, factors, processes, include amongst others:

- the specific agro-environmental circumstances
- the insufficiently adapted technology

- the knowledge of farmers
- the economy of small scale farmers
- the societal acceptance of innovations
- the availability of resources
- CA Adoption Context,
- Stakeholders within the CA Innovation system,
- Type and quality of linkages between the stakeholders.

While each theory/concept brings a unique contribution as a potential framework for explaining adoption and diffusion processes of innovations, the Diffusion of innovation Theory (Rogers 2003), and the innovation systems approach (World Bank 2006) are especially interesting not only as they have been designed and tested specifically for the field of agriculture, but because they offer the most generic (encompassing) framework for analysing systems of innovation under CA and Fish Farming.

•Table 3: Selection Criteria for theories and concepts

Assessment criteria: Does the concept / model / frame address or potentially apply to?	Diffusion theories and conceptual models as frameworks						
	Lewin (1947)	Hruschka (1989)	Rogers (2003)	Hoffmann (2005)	Adjzen (1991)	Triomphe et al. (2007)	World Bank (2006)
Attributes of innovation (e.g. CA) and their influence in the adoption and diffusion process	N	N	Y	N	N	N	N
Forces or factors influencing farmers and their possible influence in the adoption diffusion process	Y	Y	N	N	Y	N	N
The various stages in the diffusion process	N	Y	Y	Y	N	Y	N
Categories as well as characteristics of various classes of adopters throughout the adoption diffusion process	N	Y	Y	Y	N	Y	N
Contextual issues relating to the adoption	N	Y	Y	Y	N	Y	Y
Adoption/diffusion studies	Y	Y	Y	Y	Y	Y	Y
Adoption of CA or similar types of innovations	Y	Y	Y	Y	Y	Y	Y
Issues relating to the capacity of CA promoting institutions	n.a.	N	n.a.	N	n.a.	N	Y
scaling-up strategy or diffusion process	Y	Y	Y	N	n.a.	Y	N
Political and institutional frame conditions of an innovation such as CA	N	n.a.	N	N	Y	N	Y
Economic conditions of CA	n.a.	n.a.	N	N	N	N	N
Perception of the community towards CA	N	Y	Y	Y	Y	Y	N
Capturing / reflecting project goals	Y	Y	Y	Y	Y	Y	Y
Which target group does it specifically take into account?	Farmers						all actors in an innovation system
Which spatial scale does it take into account?	F/V	F/V	F/V	F/V	F/V	F/V	V/R
Complexity of innovation dealt with (from simple to systemic)	n.a.	Y	Y	Y	N	Y	Y
Innovation as an emerging / evolving technology	n.a.	Y	N	N	N	Y	N
Innovation as a fixed set technology	Y	N	Y	Y	Y	N	Y

Y= yes, N = no, n.a.=not applicable

V/R-Village and Regional level, F/V-Farm and Village level

With regards to the nature of adoption process, the theory of behaviour modification (Hruschka 1994) and the Dynamics of CA adoption (Triomphe et al. 2007) are seen to be

quite fitting. These theories/concepts therefore constitute the backbone/framework of the various articles which form the core of this work (chapters 3, 4 and 5).

2.2 Synthesis of methods and bridge to peer reviewed articles

2.2.1 Article 1: Chapter 3

This chapter is published as article I, titled: "Fish Farming in Cameroon: A Field survey of Determinants for farmers' adoption behaviour". This is a research article, which has been peer reviewed and published in the journal of *Agricultural Education and Extension*(Ndah et al. 2011). The main objective of this article is to examine the complex issue of farmers' adoption decision and to attempt an answer as to why there is a lag in the diffusion process of this innovation in Cameroon. Specific reference is made to central, southern, southwest and northwest provinces of the country. From the list of reviewed theories and concepts (chapter 2), this article specifically makes use of the theory of Behaviour Modification (Hruschka 1994) and variables of adoption of innovations (Rogers 2003) as conceptual frameworks to logically present and discuss the results. Primary data for this article was obtained through a field survey using semi structure interviews; key informants and focus group discussions.

The article shows how a theoretical and conceptual frame is combined with an empirical field survey to fill gaps in existing knowledge of Fish Farming diffusion in Cameroon. It ends by suggesting that to realise a positive impact on the adoption decision process of this innovation in Cameroon, donors should focus on: supporting medium-scale farmers, improving their organisational structures, strengthening the fragile extension system and boosting research on fingerlings production.

2.2.2 Article 2: Chapter 4

The content of this chapter is published as article II, titled: "Adoption potential of Conservation Agriculture in Africa: a newly developed assessment approach (QAToCA) applied in Kenya and Tanzania". The work has been peer reviewed and published in the journal of *Land Degradation and Development*(Ndah et al. 2012). The main objective of this article was the development of a Qualitative expert-based participatory Assessment Tool for CA adoption in Africa (QAToCA). To achieve this objective, the following steps were adopted for this article: (i) a review of adoption theories and conceptual models of innovation (chapter 2) to identify relevant factors in the CA adoption process, and their grouping along thematic areas, (ii) the development of operational questions, assessment indicators and

answer statements, and (iii) the development of the computer-based tool including its pretesting.

Exemplary application in Kenya and Tanzania was done through selected multi stakeholder focused group discussions –called QAToCA mini workshops - of approximately half a day for each case study. Results of its application in Kenya and Tanzania identified a relatively high CA adoption potential. The following factors however, are noticed to require further improvement: accessibility of markets for CA products and inputs; adaptation of machinery and seeds to the CA practices; introduction of quality implementation measures and a renewed motivation (interest) amongst CA service providers.

2.2.3 Article 3: Chapter 5

The content of this chapter now as well "in press" as article III titled: "*Adoption potential of Conservation Agriculture practices in Sub-Saharan Africa: results from five case studies"* with the *Environmental Management journal*. After developing and publishing the QAToCA tool (article II), the need to further test its suitability led to the conception of this article. It is focused on a wider application of the tool in five case studies spread across Zambia, Malawi, Zimbabwe and Burkina Faso. Like the case of article II, data for the case of Zambia was obtained through a QAToCA workshop complemented by semi structure interviews conducted during a field visit in the second half of 2011. For other case studies, the data came from collaborative QAToCA field surveys with CA2Africa project partners based in the various case study areas.

Results of the application show high CA adoption potentials for the Malawi and Zambia case related mostly to positive institutional factors. On the other hand, the Zimbabwe case shows a low adoption potential in spite observed higher national figures and this is attributed mainly to unstable and less secured market conditions for CA inputs and outputs. In the case of Southern Burkina Faso, adoption potential is assessed high and deviates from lower observed figures. This is attributed mainly to strong competition of CA and livestock over residue in this region. Lastly, the high adoption potential found in Northern Burkina Faso is explained mainly by the fact that farmers here have no alternative than to adopt a locally well adapted CA system, namely Zaï farming.

CHAPTER 3

FISH FARMING IN CAMEROON: A FIELD SURVEY OF DETERMINANTS FOR FARMERS' ADOPTION BEHAVIOUR[1]

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Impression about Fish Farming in Cameroon

Impression about Fish Farming, South west Cameroon - Kumba

3 Chapter 3: Determinants for fish farmers adoption behaviour

3.1 Abstract

Although Fish Farming in Cameroon started in the late 1940s, currently the country meets only half of its domestic demand for fish. This article examines the complex issue of farmers' adoption decisions and attempts to answer why there is a lag in the diffusion process.

The theory of Behaviour Modification and key variables of adoption form the conceptual framework of this study. The paper makes use of primary data obtained through semi-structured interviews, key informants and focused group discussion.

This paper reveals that inputs provided by public or non-governmental bodies, favourable environmental conditions and socio-cultural attitudes act together as driving factors towards Fish Farming adoption. Little administrative presence and a low local effective demand for fish have a negative effect on the adoption process. Characteristics like trialability, relative advantage and complexity of the innovation exert a significant hindrance on farmers' adoption behaviour, while compatibility and observability provide a certain explanation.

The findings clearly support the observation that Fish Farming is an attractive activity for medium-scale farmers most of whom are able to: run several ponds, and manage feeding, maintenance, storage, transportation and marketing effectively. With regard to small-scale farmers, staple food cropping is seen to have a comparative advantage over Fish Farming.

This study fills the gap in existing knowledge of Fish Farming diffusion in Cameroon. To realise a positive impact on the adoption decision process of this activity, this paper suggests that donors should focus on medium-scale farmers, on improving organisational structures of farmers, and on strengthening the fragile extension system and the research on fingerlings production.

3.2 Introduction

As a major component of aquaculture, fish pond farming in Africa dates back to the 1930s when it was first introduced (Jamu and Ayinla, 2003). However, despite steady growth, realising the potential of fish pond farming on Africa's suitable lands has been elusive (Brummett et al. 2006). Compared to other continents, this activity in Africa is still insignificant and accounted just for 0.9% (404.571t) of the total global fish production in

2000 (FAO, 2004). Shortcomings of fish pond farming on the African continent can also be observed at national levels. This paper looks at the case of Cameroon, located in West Africa. Although the activity started in Cameroon as far back as the late forties, the country "*currently, meets only half domestic demand for fish, with fish farmers contributing less than 0.1%. Recent trends indicate that, like elsewhere, most natural fisheries have reached or exceeded maximum sustainable yields. Fish imports to satisfy local demand require hard currency, which isoften lacking or scarce*" (Kouam et al. (2003, 3). The inability of the country to meet local demand for fish continues to grow each year in spite of the increasing awareness of the role this activity can play on import substitution and the country's balance of trade as well as employment and poverty reduction (Kouam et al. 2003).

The adoption rate of Fish Farming in Cameroon has been low. Moehl et al. (2004), Kouam et al. (2003) and Poumongne et al. (2002) identify the lack of fingerlings, weak extension servicesand limited access to feed as the three crucial inhibiting factors responsible for the low state of this activity. On the other hand, Ajonina (2001) and Ndah (2008) in their studies say the poor state of Fish Farming in southwest Cameroon has more to do with the lack of technical knowledge and insufficient capital as well as cultural factors. They state that cultural habits and attitudes in Cameroon play an important role on the consumer's willingness to accept freshwater fish species as part of their diets. Moehl et al. (2004, 14); Kouam et al. (2003, 5) further point out that weak research, education and training activities, the absence of producer organizations and a lack of efficient control, monitoring and evaluation are major inhibiting factors to Fish Farming in Cameroon. Without contradicting the previous studies, Soua et al. (2000) blame the nature of government policies in Cameroon for the poor state of Fish Farming. Their study emphasised that *"government has a crucial role to play in creating the enabling environment for the development of a commercially oriented, demand driven Fish Farming industry. This includes supportive policies and appropriate legal frameworks.*"

Most of the above studies unfortunately fail to investigate issues related to the core attributes of adoption as identified by E.M. Rogers (2003) and thus make it difficult to relate empirical findings within a coherent conceptual framework. There is a further lack of knowledge about how the contextual driving and hindering factors collectively affect the Fish Farming adoption decision process of farmers. The influence of the private sector as manifested in Common Initiative Groups (CIGs), Non-Governmental Organisations (NGOs) as well as in other external bodies on the adoption decision of farmers is also not dealt with explicitly in most of

the above studies. Therefore, for a better understanding of the determinants for fish farmers' adoption behaviour in Cameroon, there is a need for the listed issues to be examined. This article tries to fill this knowledge gap by specifically describingthe complexity pertaining to adoption variables, inhibiting and driving factors, and the implications for the adoption decision of fish farmers in Cameroon.

3.3 Concept and methodology

3.3.1 Conceptual background

In this paper, we pursue the general idea that the adoption of an innovation corresponds to the modification of individual behaviour. To operationalise this idea conceptually, we use the 'Theory of Behaviour Modification'(TBM)(Figure 3). It states that human behaviour is seen as a result of the interplay of diverse forces that create a set of circumstances through the dynamic interaction of man and his environment (Albrecht et al. 1989, 62). This concept is generally founded in the psychological field theory of Kurt Lewin (Lewin 1947). Behaviour is considered a function of the individual's subjectively perceived environment, in which inhibiting and driving forces are present in a state of equilibrium or dis-equilibrium with varying degrees of tension between them. Change of behaviour occurs in a three-step process: the perception of a problem or 'disequilibrium', the shift phase when new behaviour is implemented and tested and the stabilisation phase (Figure 3). For an existing state of equilibrium to be altered therefore, there is the need for:

$\Rightarrow$ an introduction of driving forces,

$\Rightarrow$ a removal of inhibiting forces or

$\Rightarrow$ a combining of these two processes.

However, within the context of this paper, the word "factors" will be used in the preceding discussion instead of "forces" for the sake of understanding.

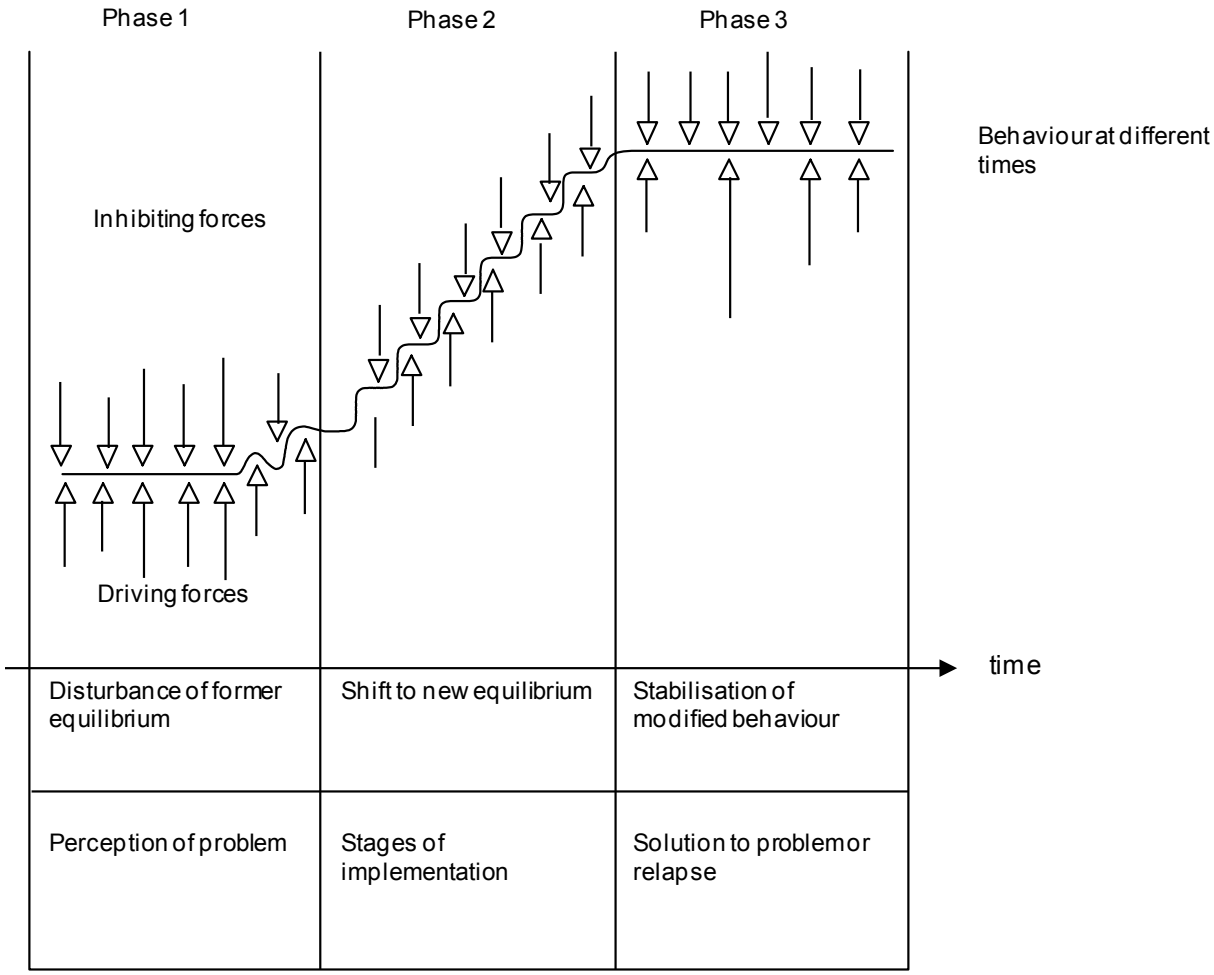

Figure 3: Three-Phase Process of the Behaviour Modification

Source: Hruschka (1994:15); after Lewin (1947)

With this approach, the underlying concept is opposite to the largely and widely applied model of Transfer of Technology (ToT) and can be related more closely to the human resource development approach (Nagel 1997). The ToT model reduces the innovation adoption process to a pure three step sequence of generating, operationalising and applying knowledge. Although this model has been widely criticised and rejected, it is still frequently applied in public and private extension programs. As it tends to neglect psychological and social-psychological aspects of human behaviour, it is not applicable in this context.

While the TBM centres the analytical attention on the subjectively perceived reality which determines the individual's field of action, a second decisive factor for successful adoption is the nature of the innovation itself. Here, extensive research has been undertaken by Rogers

(2003), who identified a certain number of characteristic attributes that render an innovation more or less apt for easy adoption as follows:

- *Comparative advantage*
- *Complexity*
- *Trialability*
- *Observability*
- *Compatibility*

These variables and the conceptual model of TBM are used for data analysis and discussion.

3.3.2 Data Collection and analysis

This article makes use of both secondary and primary data. Secondary data comes from literature research while primary data was obtained by semi-structured qualitative interviews and key informant interviews (Fontana and Frey 1994).

The choice of a qualitative approach was driven by the objective to gain a holistic overview: the logic of Fish Farming, its arrangements, and its explicit and implicit rules (Punch 2005). A set of semi-structured questions was developed, tested and administered in three provinces of Cameroon (Centre, Southwest and Northwest Provinces) (Table: 4). Interview partners were fish farmers, members of CIGs, extension workers, local authorities, NGOs and other experts.

Pond visits and observation helped in triangulating the information gathered through interviews with the real situation in the field. Tape recording of interviews, field notes and snapshots formed part of the data collection process. The survey covered a period of three months (March-May 2006).

For the three provinces visited, a total of 78 interviews were conducted, from which 54 involved farmers. Small scale peasant farmers were classified as those with 1-3 earthen ponds of 100m^2 average size. Medium to large scale farmers were those whose production objective was mainly market oriented with ponds up to 1500m^2 in average size.

Table: 4: Selected interview questions

Area of Interest	*Operational Question*
History (Origin, evolution etc)	Could you briefly describe the history of your Fish Farming activity?
Production	Briefly describe how your production process and management of your fish farm is planned.
Driving factors	Are there some particular factors that encouraged you to start Fish Farming? If yes, could you list a few of them?
Inhibiting factors	Are there moments in your Fish Farming career when you felt uncomfortable doing Fish farmer? And if any, what was responsible for this?
Observability	Are the benefits of Fish Farming easily observed by you or other farmers? If yes, which aspects are easily noticeable?
Trialability	Can Fish Farming be tried out and verified on a small scale, and extended in stages, or partially adopted?
Flexibility/adaptability	Is the implementation of Fish Farming flexible, i.e., can it be easily adapted to suit different ecological zones?
Relative advantage	Is Fish Farming implementation affordable to you in terms of cost?
Availability of Fish Farming knowledge	Is Fish Farming practice/knowledge already known to other farmers of your region?
Complexity of Fish Farming	Is Fish Farming easy to understand and implement?
Availability of Social networks/org.	Is the required social organisation for Fish Farming implementation in your community available? (e.g., marketing networks, etc.)
Residue and Seeds Requirements vs. availability	Are the initial inputs (tools, fingerlings etc.) available for your farm, and if not, do you have easy access to them, for successful implementation of Fish Farming?
Land requirement and availability	Can Fish Farming practice initially be implemented on existing farms without additional land (with special quality) required OR is the required additional land available to the farmers?
Activities of the farmer	Is Fish Farming the only activity for you?, If no, list the other activities you are presently involve with alongside Fish Farming
Fish Farming yield response and time	Can you quickly reap benefits from Fish Farming practice? If no, estimate how long it might take (it takes) before reaping first benefits from your activity.
Relative economic risk	Is the economic risk for farmers comparatively low? What is the certainty of yield? What are the consequences of failure? And what are the socio-economic circumstances and needs within and outside the target area?
Fish Farming and Social status + prestige of farmers	Does Fish Farming contribute to your autonomy, prestige, independence?
Technical knowledge requirement and availability	Is the technical knowledge (pond selection, construction, fingerlings production, feed and feeding process, pond fertilisation, pond stocking, etc.) required by Fish Farming practice initially available to you and other farmers in your area?

Data analysis for this work has been done in the form of qualitative description. Adoption indicators are aggregated and discussed against the above presented 'Variables of Adoption'

and the 'Theory of Behaviour Modification' as these form the conceptual basis for this work. Due to the interdependencies in the driving and inhibiting factors for Fish Farming, it is important to clarify and prioritise the opportunities and threats to further adoption. To do this in a systematic way, this paper regroups these factors under:

- Resources and input as factors
- Environmental factors
- Public policy and administrative factors
- Socio-cultural and religious factors
- Economic factors
- Technical factors

The listed factors are presented and discussed in relation to the introduced conceptual frame of the TBM.

3.4 Findings

Most fish farmers in the study areas fall between the ages of 40-60 years. Hence, the activity is regarded by most youths as a profession mainly for older people. Fish Farming is also considered a men's activity, and this coincides with the fact that out of the 54 interviewed farmers, only 6 were women. While 40 farmers were small-scale rural fish farmers, 14 can be classified as medium scale farmers. Only 8 out of 54 farmers acknowledge satisfaction with the state of their adoption decision when asked to make a self-evaluation in terms of the profits and benefits they enjoy from their activity. On the other hand, no farmer was found to be dependent on Fish Farming alone for survival; 45 practiced Fish Farming alongside the production of other staple and cash crops.

3.4.1 Findings on adoption variables in Cameroon's Fish Farming

In the following, selected results out of the 54 interviews with farmers' are presented with respect to the variables of adoption.

a) Relative (comparative) advantage

Fish Farming is discussed among the farmers in comparison to other farming activities. The results reveal a certain range of different opinions and assessments:

- Forty out of 54 interviewed farmers weigh fish production negatively in comparison to other farming activities. Thirty out of the 40 ranked food crops over Fish Farming,

arguing that food crops are a source of basic supply for the household while fish only forms a component of their meals (Table 5).

Table 5: Rating of adoption variables by farmers

Total number interviewed = 54

Characteristic attributes of an innovation	Farmers with positive rating (+ve influence on adoption)				Farmers with negative rating (-ve influence on adoption)			
	MS	SC	AN	%	SC	MS	AN	%
Relative Advantage	14	00	14	26	40	00	40	74
Complexity	09	00	09	17	40	05	45	83
Observability	14	19	33	61	21	00	21	39
Trialability	14	05	19	35	35	00	35	65
Compatibility	14	16	30	56	24	00	24	44

AN= Absolute number

MS= Medium Scale

SC= Small Scale

%= Percentage

- However, this category of farmers is comprised of mostly small scale farmers while, on the other hand, 14 medium scale farmers with a better financial standing, place Fish Farming over crop farming (Table 5). The latter respondents are of the opinion that with money derived from the sale of fish, they should be able to purchase the food crops they do not produce.
- Others stressed time factor issues as well as the investment cost of Fish Farming.

b) Complexity

Fish Farming is considered a very complex activity by 45 out of 54 farmers' interviewed. This finding is strongly supported by the many worries they have before starting Fish Farming, including knowledge of:

- specific requirements for a good pond site
- the water supply of the chosen site
- pond construction

- pond fertilization
- fingerlings production or purchasing sources
- the entire pond management process and
- the objective determination

Some of the farmers advanced these arguments in explaining why most of their friends are interested in Fish Farming but do not adopt it, or why some started and later abandoned it.

c) Observability

"*My wife saw the practice at her brother in-law's place and introduced it to me,"* said a farmer in Yaoundé. Fish Farming is an activity with a high level of observability. This applies mostly to ponds around the peri-urban areas, visible to potential local adopters and to visitors from different regions. Successful farmers gain the admiration of many as people often gather around ponds during harvesting, buying fish at cheaper prices or receiving as gifts. This not only strengthens their social ties with neighbours but also serves as a form of social capital. Out of the 54 farmers, 33 confirmed that they first observed and copied the technology from neighbours or friends (Table 5). The second group said they were initiated into the activity by either national or international bodies (16 out of 54). The third group is made up of those who inherited the technology from their predecessors (6 out of 54).

Nevertheless, only external aspects of Fish Farming are observable, but issues related to individual farmers' tacit knowledge can never be observed; for instance, a farmer's educational attainment or personal motivation can never be observed or copied just by looking. This explains why 12 of the 54 farmers stated other sources and reasons why they started Fish Farming apart from observation.

d) Trialability

"*I decided to try after visiting a friend in Yaoundé and noticing that he was making money out of Fish Farming,"* remarks a farmer. After observing the activity, farmers proceed by starting cautiously. Expansion of the fish farm by a farmer to two, three or more ponds in subsequent years depends on the feedback the farmer gets after harvesting and selling or consuming his output from the first pond. Nineteen farmers said they started off by trying at a very small scale then decided to continue by expanding to two or three ponds (Table 5). The argument

they advanced is that the hardest labour input is at the initial stage of starting one fish pondand that the subsequent ones become a lot easier.

Among the 54 farmers, 35 confirmed that it is difficult to even start because they lack the large capital needed. Questions arise as to whether trialability is considered with regard to size or number of ponds.

e) Compatibility

Compatibility in the cultural sense was a frequently mentioned issue. Fish Farming is seen to fit well with most of the customs and traditions of the villages visited. Generally, most people in Cameroon eat fish except for religious or personal reasons. Even in cases of religious preference negative bias applies only to some types of fish (Scale-less fish in the case of the 'Seventh-day Adventist Church'). This explains why 30 of the 54 farmers acknowledged that Fish Farming fits well in their socio-economic and cultural practices. Limitation to this is seen when Fish Farming competes with other forms of farming due to the amount of work it entails.

Tentative Conclusions on Variables of Adoption

Analysing the findings with respect to the variables of adoption, we find that the attributes; 'trialability', 'relative advantage' and 'complexity',characterise Fish Farming in a way that makes it less attractive to the majority of the interviewees. Only 14 of the 54 farmers acknowledged a relative importance of Fish Farming over crop farming. And 35 farmers deplore the perceived difficulty in 'trialability'of the activity. Even a higher number, namely 45 farmers, confirmed that the many questions that always need to be answered render the activity highly complexand hence hinders adoption. Therefore, it can be concluded that these attributes 'trialability', 'relative advantage' and 'complexity', imply a significant hindrance on the adoption behaviour. In contrast, 'compatibility' and 'observabilty' with a positive rating by 30 and 33 farmers respectively provide a stronger explanation for the adoption behaviour of the interviewed fish farmers

3.4.2 Findings on driving and inhibiting factors in Cameroon's Fish Farming

In this section, driving and inhibiting factors are regrouped, presented and discussed in relation to the conceptual approach (TBM) as introduced in section 2.

a) Resources and input as influencing factors

Financial and material assistance play a significant role in Fish Farming adoption. NGOs such as the Presbyterian Rural Training Centre (PRTC) Fonta-Bamenda, providing the necessary training to farmers, have in the past also actively supported them with farm equipment. Most farmers attributed their reason for adoption to the guarantee of receiving this support. Other farmers belonging to one of the CIGs benefit from the groups' financial resources. Many financial institutions see the members of a CIG as reliable when it comes to giving out credit. Davis et al. (2004) earlier confirmed this aspect of groups' reliability.

The lack of good quality fingerlings in Cameroon is a severe setback that cuts across the country. Access to species of fingerlings such as Clarias (*Clarias gariepinus*), Common Carp (*Cyprinus carpio*) Heterotis (*Heterobranchus longifilus*) and others is limited in general and completely absent especially in Northwest Cameroon. Limited technical knowledge on the production process is confirmed by most farmers.

The difficulty of where and how to get feed was confirmed by most farmers. The few sellers are often located far from where the farmers live. Insufficient knowledge of on-farm feed production coupled with bad seasonal roads linking farms to sources of feed from the towns is a major handicap.

The lack of storage devices causes a serious post-harvest problem. As a consequence, most of the fish is usually sold cheap in order to liberate the stock. Off-farm sales in larger markets are hardly possible, as there are no fast methods of transportation or conservation devices. Most small scale farmers confronted with these problems quickly stop producing because they are unable to cover production costs once the promotion period is over. In such instances, the donor projects' objective of 'providing local food' is temporally met, but the aim of general innovation diffusion and sustainability of the activity remains fragile.

b) Environmental factors

Some farmers start Fish Farming simply because they have access to potential sites. *E.g.* 'swamps' are marginal lands that are usually not good for crop cultivation but are ideal for Fish Farming.

Favourable topography acts as a driving force especially in the Centre and Southwest Provinces of Cameroon. Hence, there is a relatively larger number of medium-scale fish

farmers, where because of the level topography, farmers are able to construct large ponds of commercially manageable sizes. Ponds of up to 1500 m^2 include 9 out of 37 ponds visited in theSouthwest Province and 10 out 49 ponds visited in the Central Province. In contrast, in the Northwest Province the authors identified only 5 out of 35 ponds with a size of 1500m^2 or more.

Soils in the three provinces visited are mostly favourable for pond construction and maintenance, as they are mostly either wet volcanic soils, humus or clay soils. The humid condition plays a positive role in pond construction as this assist in reducing the rate of water infiltration and percolation in ponds. Water retention level in ponds is, therefore, high and hence a good factor for pond productivity. However, water supply, dense vegetal cover, topography, floods and sandy soils were mentioned by some farmers in the Northwest Province as environmental obstacles. Specifically in the case of Bafut village (Northwest Province), farmers usually observe a shortage during the dry season (October to late January) when water in ponds drop, and farmers are forced to harvest or reduce the stock of fish in concentrated ponds in order to avoid losses.

Vegetation cover in swampy areas is a common problem. Such sites are fertile grounds for the growth of water plants with long taproots. Clearing this grass before pond construction or rehabilitation is usually labour intensive. Neighbouring raffia palm bushes as well as dense canopied forest serve as home for predators (snakes and birds). These canopies also block the free penetration of sunlight, which is vital for plankton growth in ponds. This situation is exacerbated in those cases when the farmer does not own the neighbouring plots and so has no control over them.

c) Public policy and administrative factors

Some governmental policies encourage the adoption of Fish Farming: for instance, the taxation policy whereby farmers' CIGs are exempted from paying taxes to the government.There is the presence of Agricultural Schools (e.g. University of Dschang) with graduates who offer advisory services to farmers after finishing their studies. Experts from Agricultural Ministry and trained area extension agents also offer technical and advisory role to farmers.The administrative set-up in Cameroon, while appearing to be well coordinated, gives room for corruption and delays. According to Ndah (2008), expert analysis revealed that because information, finances (budget) and support materials to fish farmers pass through a

highly condensed bureaucratic set up, it often leads to a time lag before farmers' problems are addressed. Allocated finances to farmers and other support often disappear or are reduced to the barest minimum along the bureaucratic chain (Figure 4) due to a lack of transparency, effective monitoring and control in the entire system.

In Bafut village, one farmer remarked that the extension-to-farmer ratio is disappointing with a single extension worker expected to cover a whole district. In this case, one extension

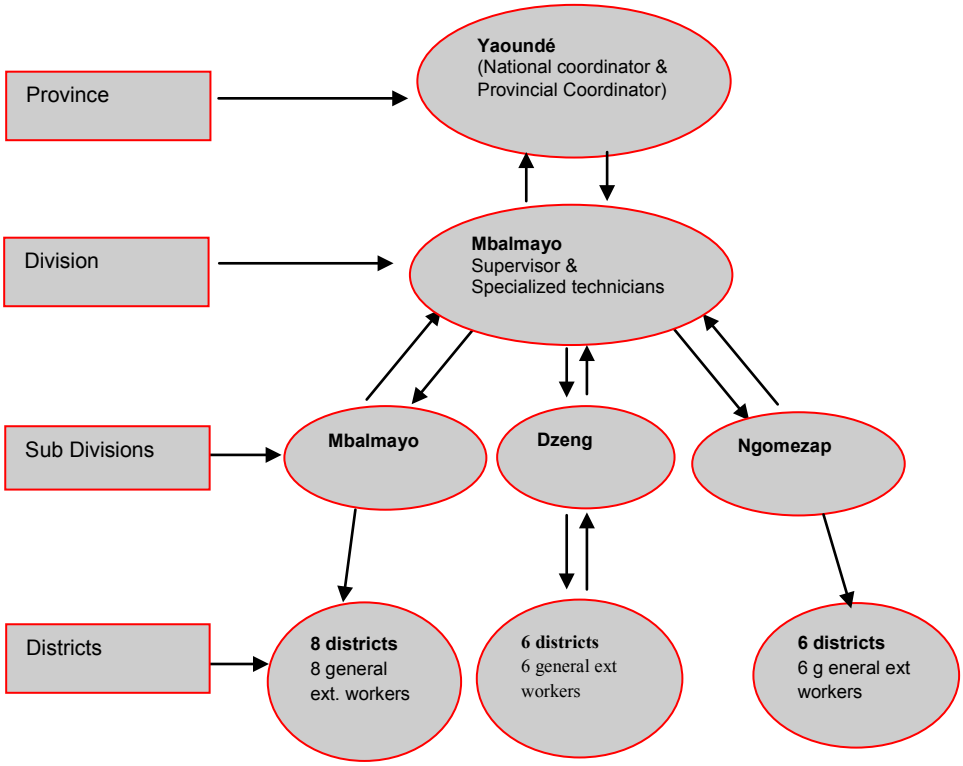

Figure 4: A hierarchical organisational scheme in Fish Farming extension in Cameroon-Case of Mbalmayo

Source: Ndah, 2008

worker was in charge of the entire village of about 125.000 people, 80% of whom are farmers. This leads to inefficiency, and the situation is exacerbated by the lack of logistics.

d) Socio-cultural and religious factors

It is a general belief among those interviewed that because of missionary activities there is an increasing number of Roman Catholic Christians. This also leads to an increasing demand for fish by Christians on days when the religion forbids them from eating meat, or on festive

dayssuch as Christmas, New Year, and Easter celebrations. Hence, farmers usually plan their harvesting around such periods.

Some farmers agreed that the spirit of collectivism among them sustains social security in regard to fish ponds; hence, the fear of fish theft in most areas is reduced. Collectivism has further helped to reduce jealousy and hatred; thus, social friction related to boundary disputes is minimised. Nevertheless, many among the interviewees state that in a community lifestyle, a single farmer's pond is conceptually regarded as the property of the whole village so protection as well as maintenance is assumed to be the joint responsibility of the entire village. In some villages within the provinces, the farmers say they are affected negatively by collectivism because they usually end up selling their fish to their neighbours at negligible prices or even giving some as gifts. Such farmers are bound to remain at a small-scale level as they are barely able to cover running costs.

Another example of a socio-cultural hindrance has been detected in central and southwest Cameroon, where it is sometimes possible that superstitious consumers refuse to buy relatively cheap catfish because they fear that a big fish is subject to magic or supernatural factors.

e) Economic factors

In the villages visited, the supply of fish from farmers is still far from meeting local demand. With a rapidly increasing population, demand is increasing as well, especially in big towns like Yaoundé, Kumba, Limbe, Buea, and Bamenda. There is an even stronger demand at most of the big hotels, boarding schools, restaurants, etc. This fast-developing market is no doubt attracting rational-thinking farmers to reallocate their resources into the Fish Farming business. The 2006 bird flu pandemic caused a sharp rise in prices of substitutes to chicken such as fish. Although the impact of bird flu on adoption has not yet been examined, it can be assumed that some farmers have been encouraged to adopt Fish Farming as a result of the pandemic.

"*The fluctuating world market prices for cash crops like cocoa and coffee have led to diversification in farming activities,*" remarked an expert in the Southwest Province. Some farmers say it is in the course of these unstable world market prices that they adopted Fish Farming. Farmers, who formerly practiced poultry and pig farming, were encouraged to adopt integrated Fish Farming so as to make efficient use of their resources (labour, money, land,

feed, etc.). For others, the calendar for crops such as maize has resting intervals within it, which are then used for pond activities.

Nevertheless, economic factors also play an inhibiting role. Market-oriented farmers remarked that hunting, which is still practiced by many, has a negative impact on the market for pond fish. "*This is because though fish and bush meat are both protein sources in the local markets, consumers in some regions prefer bush meat over pond fish," remarked* a fish seller in the Centre Province.

f) Technical factors

Site selection, basic feed mixture and feeding procedures are all technical issues raised by the fish farmers interviewed.

International donors have played a role in the introduction of Fish Farming (*or aquaculture*) in Cameroon (Table 6) not only by offering financial assistance, but also by training farmers on basic technical issues linked with the activity (e.g., site selection, feed mixture, pond construction and general pond management). However, some farmers adopted Fish Farming when they were sure of continuously receiving support. When such support came to a halt, they quickly abandoned the activity. The presence of the WorldFish Centre in Cameroon through its aquaculture experts is playing a motivating role in this regard but this is limited to the areas around Yaoundé (.Table 6). Nineteen out of the 54 farmers interviewed had received direct or indirect benefits from the services of the WorldFish Centre in Yaoundé. Reliance on external support, therefore, is one major reason why the adoption process in Cameroon has been project driven.

Table 6: Major development projects from 1948 to 2006

Period	Funding (US$)	Foreign Implementing agency	Main Objectives	Assessment based on project Performance/Sustainability
1948-1960	France and Britain	French and British	Poverty alleviation, Food security	-
1960-1980	-	-	-	-
1980-1984	USA	Peace Corps	Training extension staff, small-scale Fish Farming	Poor
1987-1992	Netherlands;$260,000	Haskoning Consultants	Station construction at Lagdo; develop technology for flood plain Fish Farming (tilapia-clarias, rice-fish)	Poor
1987-1991	International Development Research Centre (Canada); $400,000	Consultants	Integrated Fish Farming research & extension (tilapia-clarias, poultry, pigs)	Average
1991-1995	Agence Général de Coopération pour le Dévelopment (Belgium); $450,000	Catholic University (Leuven)	New species for Fish Farming, freshwater fish inventory	Poor
1988-2000	USA	Peace Corps	Participatory technology development (tilapia)	Average
2000-2005	Department for International Development (UK); $1,500,000	WorldFish Centre	Aquaculture development participatory research	Good
2000-2008	Cameroon (HIPIC project), France (REPARAC project) $1,000,000	CIRAD	Fish seed production, aquaculture development, participatory research	On going

Adapted from Pouomogne (2003), Pouomogne and Pemsl (2008)

Nevertheless, a few farmers in the southwest consider fish as wild animals, so that after putting the fingerlings in the pond, they only visit it again to check if the fish are ready for harvesting. This group of farmers does not recognise Fish Farming as a complex activity.

Tentative conclusion about driving and inhibiting factors

The analysed influencing factors can be easily perceived as either fostering or hindering factors. Judging and weighing the influence of each factor as performing a driving or inhibiting role by interviewed farmers are mostly based on the perceived gain and tradeoffs in adopting Fish Farming activity. From the findings of this study, the authors derive that public and non-governmental resources, the mostly favourable environmental conditions and the rather open socio-cultural attitudes act together as driving factors for the adoption of Fish Farming activities in the regions visited. On the other hand, little administrative presence and a rather low local, effective demand for fish do not encourage small farmers to engage more actively in this activity. Farmers with a certain productive power can profit from specific demand in towns and from wholesalers when they overcome infrastructural challenges. Collectively, these factors present an integrative picture of the multiple influences on the intended behavioural change. And all in all, the analyses reveal a certain dominance of inhibiting factors over driving factors, which is the reason for the current slow adoption processes.

3.5 Discussion of findings

The findings of the empirical study on factors and variables influencing farmers' adoption of Fish Farming practices in three provinces of Cameroon have yielded a rich picture reflecting the complex reality of an innovation adoption process.

Results clearly support the observation that Fish Farming is an attractive activity for medium-scale farmers most of whom are able to run several ponds and manage feeding and maintenance correctly as well as organise storage, transportation and marketing effectively. With regard to small-scale farmers, staple food crops have a comparative advantage over Fish Farming because these farmers regard fish as a supplement of their diet. To some, fish is a luxury or a socially shared resource that serves to mutually strengthen linkages between villagers.

However, with regard to trialability, hidden agendas might guide initial pond digging. Referring to a case study in Zambia, Harrison (1993: p54) said, "*Some farmers use ponds to claim land, as a long term inheritable asset and above all as a means of joining the development culture."* These small attempts highlight that the objective of the initial trial might not necessary aim at eventual adoption, a similar situation observed in the villages

visited during this survey. Such hidden agendas are often aggravated by the lack of efficient control, monitoring and evaluation as confirmed by the earlier findings of Moehl et al. (2004, 14) and Kouam et al. (2003, 5)

Farmers are seen to have positive socio-cultural attitudes towards Fish Farming, and this is further emphasized by its corresponding attribute of compatibility as an innovation to the varied socio-cultural norms across the different villages. This no doubt presents a positive picture of the activity in the country; although in terms of adoption and diffusion, a collective consideration of these factors reveals inhibiting factors weighing more than driving factors, which is the reason for slow adoption.

3.6 Conclusions

The adoption process for Fish Farming in Cameroon as studied through semi-structured interviews with farmers in three provinces is still in its beginning. Most farmers are still in a state of trial, and ready to interrupt the activity as soon as problems occur, e.g., infrastructural problems or low economic demand. Additionally, external support is frequently in the frame of international projects, i.e., within a given time frame, and public extension services are nearly negligible. On the other hand, a certain number of farmers have reached the state of performing production and mastery. If these successes are to grow, more support for innovating farmers is needed, both in terms of access to knowledge and infrastructural resources. Then, population growth and increasing demand for fish in towns and centres might do its part and serve as an attractive market.

At the national level, the public sector has basically failed in its functions. The private sector is proving to be the better partner and is fast gaining the support and confidence of the farmers. Obviously, Cameroon's Fish Farming is still in the critical phase of the diffusion process of aquaculture innovation. In several cases, the appraisal of the innovation's characteristics coincides with either fostering or hindering factors as perceived by the farmers. Therefore, it can possibly be concluded that:

- the inconvenient complexity of the innovation corresponds very well with the observed absence of public training and extension support,
- the uncontested fact of observability makes Fish Farming worth a trial also under conditions of low effective demand and hence for family or local consumption and

- the compatibility of observed Fish Farming reflects the fact that though there is a certain dominance of inhibiting factors, there is still as well an accommodating socio-cultural environment to this activity.

Summarily, to reach the self-propelling or stabilisation phase in Fish Farming production, attempts should be made to maintain and fortify the mentioned driving factors, and to reduce crucial inhibiting factors. Specifically, there is the need for 1) donors to focus their attention on medium-scale farmers, 2) improvement of the organisational structures of farmers and market networks, 3) strengthening the fragile extension system and 4) more research on especially fingerlings production.

3.7 Acknowledgement

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CHAPTER 4

ADOPTION POTENTIAL OF CONSERVATION AGRICULTURE IN AFRICA: A NEWLY DEVELOPED ASSESSMENT APPROACH (QATOCA) APPLIED IN KENYA AND TANZANIA[2].

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Keywords: Conservation Agriculture; Conservation farming; adoption potential; assessment approach; QAToCA; Africa.

Impression about Conservation Agriculture and mechanization levels during my field visits

4 Chapter 4: Developing a participatory assessment approach

4.1 Abstract

Conservation Agriculture (CA) is often promoted as a set of cropping practices to reduce soil erosion and maintain soil fertility, while decreasing production costs and increasing crop yields. However, CA adoption is extremely low in Africa. Most investigations on constraints of its adoption leave out: 1) the characteristics of CA as an emerging innovation and, 2) the wider institutional context. A comprehensive self-assessment tool for a systematic evaluation of factors influencing the CA adoption process at the field, farm and regional scale in a variety of regional contexts in Africa is still lacking. In an attempt to fill this knowledge gap, this article presents the motivation, development and testing of a Qualitative expert Assessment Tool for CA adoption in Africa (QAToCA) and its application. QAToCA is directed to regional experts, research teams and managers of development projects with a focus on CA, and allows them to assess their CA activities along a systematic, expert-based list of questions and criteria. Specifically, it aims at assessing the adoption potential of CA under the varied agro-ecological, socio-economic, cultural and institutional conditions of Africa as well as the specific supporting and hindering factors influencing this process.

As an example, its application in Kenya and Tanzania identified a relatively high CA adoption potential. The following factors however, are noticed to require further improvement: accessibility of markets for CA products and inputs; adaptation of machinery and seeds to the CA practices; introduction of quality implementation measures and a renewed motivation (interest) amongst CA service providers.

4.2 Introduction

Conservation Agriculture (CA) is often promoted as a cropping practise that reduces soil erosion, increases yields and reduces labour requirements (Giller *et al.* 2009). It relies on the simultaneous application of three basic principles: 1) minimum soil disturbance or no-tillage, 2) permanent soil cover and 3) diversified crop rotations or associations (FAO 2008). However, CA adoption rates are low in Africacompared to other continents with comparable agro-ecological conditions e.g. South America (Gowing and Palmer 2008). In general, farmers in Africa do not spontaneously practice CA for a number of reasons unless some technical and/or financial support is provided through e.g. external funding (Baudron *et al.* 2005, Giller *et al.* 2009). For one, deficient infrastructures, small farm sizes and low educational level all play a role against CA adoption. Other key limiting factors include land (especially due to land tenure arrangements and small farm plots); labour at key periods during the cropping cycle (often due to migration to cities and farmers' inability to pay for the scarce labour present in the villages); limited crop residues for mulching (due to competition for use as feed for livestock); and lastly; capital to invest in external inputs (herbicides, specialised no-tillage implements, cover crop seeds), also due to limited credit facilities. Investment in CA furthermore seems to compete with the basic needs of farmers (FAO 2008).

Assessing this situation, authors such as Erenstein (2002), Giller et al. (2006) or Knowler and Bradshaw (2007) have concluded that the potential of CA adoption is site-specific and depends on the local biophysical, socio-economic, cultural and institutional environment which needs to be given special consideration in any attempt to identify constrains to adoption. Sumberg (2005) for his part calls for a distinction between variables that are exogenous to the fit between an innovation and specified group of potential users to those that are endogenous (i.e. prerequisite conditions).

Despite the above emphasis on site specific analysis and categorisation of constraints to explain CA adoption, very few studies have considered this systematically. While some studies have attempted to identify the driving and hindering factors to adoption of CA for selected case studies, they have done so without using a holistic and contextual approach (Baudron et al. 2005; Boahen et al. 2007; Bolliger et al. 2005). Also, a comprehensive tool for a systematic assessment of factors influencing the CA adoption process from field, farm to regional scale and for use in a variety of regional contexts, is still lacking.Yet such a tool

would help the many CA researchers, practitioners and other managers of on-going projects with a CA component throughout Africa to reflect on their CA-related activities and to eventually adjust or redesign them based on a more explicit understanding of where problems and opportunities are found. In particular, such a tool would help in assessing systematically under which ecological, socio-economic and institutional conditions CA is best suited for smallholder farming in Africa (Giller et al. 2006) and determine, what is the potential for scaling up CA adoption.

The objective of this paper, therefore, is to describe the development of a qualitative expert-based assessment tool that facilitates the systematic identification of supporting and hindering factors to CA adoption as well as assessment of the relative CA adoption potential in a given region, and to report from the testing of the tool in two African case studies, located in Kenya and Tanzania. The potential for CA adoption is not a prediction of actual adoption rates. Instead, our aim was to systematically check relevant factors that may influence CA adoption as identified in the literature. The expert assessment tool delivers an assessment of how suitable conditions and thus the likelihood for CA adoption are.

4.3 Methods for tool development

The Qualitative expert-based Assessment Tool of CA adoption in Africa (QAToCA, pronounced ka:toka:) has been developed as a self-assessment tool directed to regional experts, research teams and managers of development projects with a focus on CA, and enables them to assess CA projects along a systematic list of questions and criteria. The tool allows for an assessment of the relative CA adoption potential in different regions and for diagnosing the supporting and hindering factors to CA adoption in a given case study.

The development of QAToCA included the following steps: (i) a review of adoption theories and conceptual models of innovation to identify relevant factors in the CA adoption process, and their grouping along thematic areas, (ii) the development of operational questions, assessment indicators and answer statements, and (iii) the development of the computer-based tool including its pretesting (Figure 5**: Work flow and phases of QAToCA approach**)

4.3.1 Review of CA influencing factors and grouping along thematic areas

Table 7, lists the concepts and frameworks considered in the literature survey as well as their core ideas. Relevant factors from these concepts and some other related studies influencing the innovation decision (in our case CA) were gathered, structured and grouped based on their thematic focus. In total, seven thematic areas (A-G) could be identified (Figure 5). The thematic stratification was done with a consideration of the different scales involved from farm scale to village/local and regional scales.

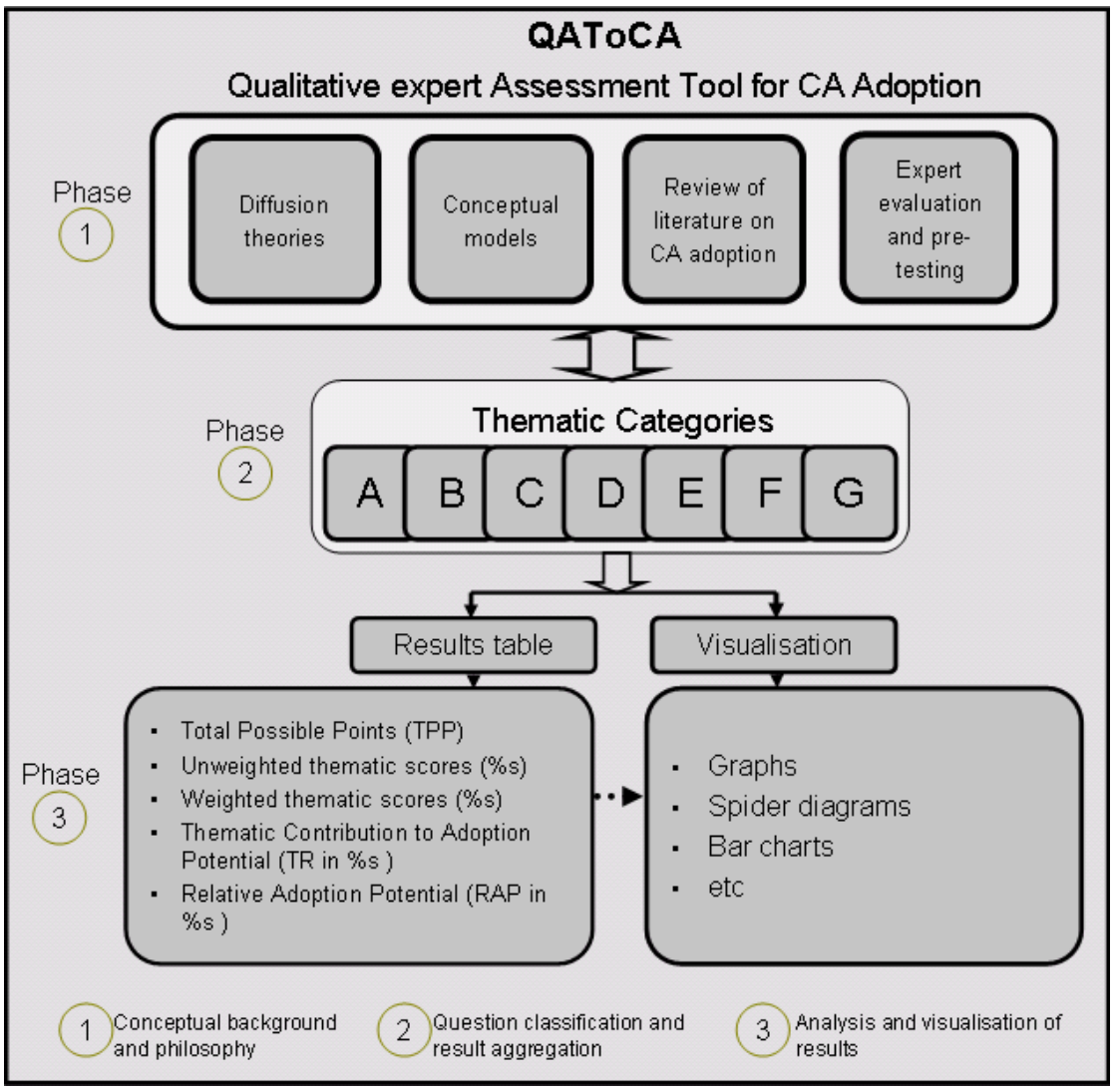

Figure 5: Work flow and phases of QAToCA approach

Thematic area A: Characteristics of CA as an object of adoption, dwells on issues related to the characteristics of the CA innovation, and in particular, the relative advantage, compatibility, complexity, trialability, and observability of CA. Such attributes may explain about 49 to 87% of the variance in rate of adoption of innovations(Rogers 2003).

Additionally, financial requirements of CA (Bringe *et al.* 2006), its knowledge intensive nature, labour requirement, rate of returns (profitability) and risk, as identified by Kassam et al. (2009), are considered, as well as general issues at the farm and household level addressing the concerns relating to the influence of CA on natural resources, farmers prestige and autonomy (Hoffmann 2005) (Table 7).

Thematic area B: Capacity of the implementing organisation(s), highlights on the fact that "an *innovation's rate of adoption is also affected by the extent of change* agents' *promotion efforts*" (Rogers 2003 pp 208). It assesses the specific capacity of the respective CA promoting organisations by specifically checking on the overall philosophy of the organization (Bringe *et al.* 2006), the type and quality of staff (Milder *et al.* 2011), leadership quality and connectivity of the institution or the level of network and inter-activeness of the promoting organisation (Rogers 2003).

Thematic Area C: Attributes of diffusion strategy, relates to the diffusion strategies used in the promotion process, which also influence significantly the rate of adoption of an innovation (Rogers 2003). Specific areas of focus include the overall objective of promotion (Derpsch and Friedrich 2009), the organisation's level of documentation, monitoring and evaluation (Milder *et al.* 2011), the type and quality of communication channels (Rogers 2003), the organization's level of involvement in capacity building as well as the extent and amount of incentives used for stimulating adoption of CA (Hruschka 1994), and the possibility of fall-back after the project (Triomphe *et al.* 2007).

Thematic area D: Political/institutional frame conditions at regional level, has to do with the political or institutional frame conditions of the region. It further checks on who actually is involved in the CA innovation system, the various levels and degree of interaction within the network as well as implications of this for CA adoption potential (World Bank 2006), the level of political stability (Derpsch *et al.* 2010), the tolerance level of the civil society towards CA (Bringe *et al.* 2006), the system of administration and its effect on CA promotion (Derpsch *et al.* 2010). In addition, this theme covers issues related to the nature of administrative set up (Ndah 2008), types of policies and their possible influence on the CA adoption.

Table 7: Contribution of theories and concepts to thematic areas of the assessment tool

Theory/Concepts	Relevant aspects considered for the operational questions in the respective thematic areas of QAToCA	Thematic areas of QAToCA
Rogers (2003 pp 207)	The aspects of perceived attributes of an innovation (complexity, trialability, compatibility, observability, relative advantage) as determinants for the adoption of innovations	**A**
Rogers (2003)	The extent of change agents' promotion efforts as a determining variable to adoption	**B**
Rogers (2003 pp 207)	The concept of communication channels as a determining variable to adoption of innovations	**C**
Triomphe et al. (2007)	The suggestion of possible pathways towards adoption of innovations (e.g. CA), implications of this on planning the dissemination strategies of organisations. For instance, use or no use of incentives	
Hruschka (1994)	The concept of behavioural change through phases by either removal of inhibiting forces, addicting driving forces or both. Implication of this on promotion of innovation and adopted dissemination strategies.	
Rogers (2003 pp 206)	Type of innovation-decision process (collective, optional, authority) as determinants for the adoption of innovations	**D** **E**
World Bank (2006)	Use of the "Innovation Systems approach": that stresses on the need for all actors and their interactions jointly involve in the production and use of knowledge. It equally deals with the rules at both the institutional and policy context that shape the processes of knowledge access, sharing and learning.	
Roger (2003 p 213)	Relative advantage and market forces as determinants to adoption of innovations	**F**
Lewin (1943)	Individuals and subjective perception of innovations (environment) as an explanation to human behaviour, behaviour as a function of a field of forces	**G**
Rogers (2003 pp 208)	Nature of social system, structure, roles, norms and traditions as preconditions for explaining rate of adoption of innovations	
Rogers (2003pp 252)	Innovativeness and adopter categorisation (innovators, early adopters, early majority, late majority, laggards) with implication of this on rate of adoption of innovations	
Hoffmann (2006)	The aspect of phases of diffusion process (innovators as disruptive elements, the critical phase, transition to self-propelling and finale phase of the wave) and implication on adoption of innovations	

Thematic areas
A: Characteristics of CA as an Object of Adoption (ObjectofAdopFarmVillLev)
B: Capacity of Promoting organisations (CapacityofPromOrgVillRegLev)
C: Attributes of Diffusion Strategy (AttrOfDiffusStratVillRegLev)
D: Institutional Frame Conditions at Regional Level (InstFramCondRegLev)
E: Institutional Frame Conditions at Village Level (InstFramCondRegVillLev)
F: Market Conditions at Village and Regional Level (MarkCondVillRegLev)
G: Community's Perception at Village and Regional Level (ComPercepVillRegLev)

Thematic area E: Political/institutional frame conditions at village level, assesses the state of local level governance structures and institutions with their likely influence on CA adoption.

The compatibility of CA as an emerging innovation with local customs and traditions (Rogers 2003), issues of land access, ownership and use of such land and the possible influence of this (Derpsch and Friedrich 2009) on the CA adoption process are equally assessed.

Thematic area F: CA products and input market conditions at village and regional level, addresses issues specifically related to market availability and access, as "*market forces undoubtedly are of importance in explaining the rate of adoption of farm innovations"*(Rogers 2003 pp 213), the availability of basic infrastructures such as farm to market roads and irrigation possibilities as well as the level of other economic actors' engagement in CA promotion (Ehui *et al.* 1992). A further check is made on the availability of quality control measures and implementation (Bringe *et al.* 2006).

Finally, thematic area G: Communities attitude towards an innovation and its adopters, summarises the individual and communities' perception of innovations as well as potential categories of adopters in their respective social systems and implications on the adoption potential of innovations. This follows Lewin (1943) who argued that human behaviour is a function of the interaction of the individual and his subjectively perceived environment, and Rogers (2003) who stressed that the social system, its structure, norms, roles of opinion leaders and change agents, types of innovation-decisions and consequences of the innovation all determine the rate of adoption within a given social system. This theme checks on the acceptability of CA by the community, as well as village leaders and influential persons in the decision making process of the village (Hoffmann 2006). The level of young farmers' commitment to CA is further checked here as well as a measure of the dynamic and innovative level of the CA community under consideration (Bringe *et al.* 2006).

4.3.2 Development of operational questions, indicators and answer statements

Each of the seven (A to G) thematic areas was underpinned with specific operational questions that address the particular factors under each theme. The draft list of questions (~ 45) was distributed among four CA experts (two in CIRAD-France, one in WU-Netherlands and one in CSIC-Spain), selected based upon their publishing activities in the CA field, for evaluation and suggestion of additional criteria. This process ended with a total of 53 questions spread across the various themes.

Each operational question is linked to one assessment indicator and four possible answer statements, and the user of the tool has to assess which of these statements applies best in the region under consideration. The order of the statements reflects their influence on the

adoption potential (from highest to not influential). To allow for calculation of the adoption potential and the contribution of each thematic area, each statement is assigned a value from0-2, indicating the weight/strength of the suggested statement with respect to their influence on the potential of adoption with 2 being highest influential (maximum positive effect on adoption) and 0 being least suitable (no positive effect on adoption). If a particular statement is not appropriate at all, the respondent has to choose the fourth option "N", for "not appropriate" including the possibility for leaving a comment. Questions answered with "N" are not included in the calculation but accompanied comments are used for a better judgement of the case study.

For example, for thematic area A, the first operational question (A1) is "Are farmers able to meet the financial cost of CA in your case study?". The indicator to be assessed for this question is "Cost of CA and liquidity issue" and the related answer statements are:

- "There are sufficient own financial resources by average farmers to cover cost" [2],
- "There are limited own financial resources, but credit institutions are available and farmers can assess loans" [1] and
- "Credit institutions are absent and farmers need major financial assistance from the promoting organisations [0]
- Question is not appropriate [N]

By selecting the first statement [2] the respondent considers that this is the statement most closely reflecting the observed situation in the specific region or case under consideration (There are sufficient own financial resources by average farmers to cover costs).

Assessment results are aggregated for each thematic area (A-G), as specified in equation 1, to identify which of these areas is potentially responsible for the level of CA adoption in a given study area.

$$RT_x = \frac{\sum_{i=1}^{n} a_i}{\sum_{i=1}^{n} a_{\max}} * 100 \qquad \text{(equation 1)}$$

with

RT – relative adoption potential for thematic area x (in %)

n- total number of operational questions in thematic area x

a_i – value (2, 1, 0) corresponding to the answer statement selected for operational question i

a_{max} – maximum possible value (2) for operational question i

4.3.3 Development and testing of the computer-based tool

QAToCA has been implemented in MS Excel ©, a software product that is widely used and therefore well-known to a variety of users. The Excel file contains a sheet for each thematic area and a results sheet summarizing the results both in percentage and graphically. The QAToCA questions catalogue can alternatively be printed out to allow for paper-based filling out. The questions catalogue is found in the supplementary online resource 1-7 for this paper.

The tool was tested in autumn 2010 during regional workshops organised by the research project "Conservation Agriculture in Africa: Analysing and FoReseeing its Impact – Comprehending its Adoption" (project acronym CA2Africa; www.ca2africa.eu) in Tanzania, Zimbabwe, Burkina Faso, Madagascar, and Tunisia, involving experts on CA from different disciplines. In each regional workshop, a session was allocated for deliberation on the tool development. Difficulties encountered were pointed out and comments gathered alongside suggestions for improvements in an iterative manner. Further collection of feedback by email correspondence with these experts continued after these workshops, resulting in the final version of the tool.

Overall, the tool was positively received, but several adaptations were suggested and taken on-board. For one, a French version of QAToCA was developed. Additionally in order to minimize, biased assessment, and with the assumption that one expert alone hardly had knowledge about all issues considered in the tool, it was decided that QAToCA was to be collectively filled out by a focus group. The proposal was to organize a workshop-like meeting allowing enough time for discussions (approx. half a day), facilitated by somebody knowledgeable about the tool, able to guide the group of participants through the entire assessment and in charge of documenting discussions. The composition of the focus group must reflect different views and experiences about CA, and hence should ideally include at least a researcher, an extensionist/promoter of CA, a farmer with appropriate CA knowledge (adopter) as well as a farmer who adopted, but stopped practicing, or who considered adoption, but then did not implement it (non adopter).

4.4 Application of QAToCA in East Africa-Case of Bungoma and Karatu

Case studies and results of QAToCA application

Subsequent to the development and pretesting phases, QAToCA was applied to two case studies (Table 8), located in Bungoma, Kenya and Karatu, Tanzania. Both case studies were part of the Conservation Agriculture for Sustainable Agriculture and Rural Development (CA-SARD) project[3] (http://www.fao.org/sard/). Main interventions in the two regions were the adaptation and testing of CA technologies through approaches that included CA demonstration plots, Farmer Field Schools (FFS)[4], field days and exchange visits aiming at capacity building and creating awareness (Table 8).

A one day QAToCA focus group workshop was organised on the 7th of October 2011 at the African Conservation Tillage (ACT) network's office in Nairobi, Kenya for filling out the QAToCA tool. The participants were selected from the two regions based on their knowledge of the case studies under consideration as well as their involvement in the on-going CA promotion efforts (except for the sceptical farmers). The group composition (n= 10 in total with 5 for each case study) included CA experts (researchers), sceptical CA farmers (non adopters), service providers, CA farmers (adopters) and extension workers.

[3]CA-SARD Project was funded by the German Ministry of Agriculture and Consumer Protection (BMVEL), organised by the Food and Agricultural Organisation of the United Nations (FAO) and coordinated by the African Conservation Tillage network (ACT) with the main objective to improve food security and rural livelihoods of small and medium scale farmers by promoting CA

[4] The Farmer Field School (FFS) is a group-based learning process that has been used by a number of governments, NGOs and international agencies to promote Integrated Pest Management (IPM) http://en.wikipedia.org/wiki/Farmer_Field_School

Table 8: Case study description

Region	Bungoma, Kenya	Karatu, Tanzania
Location	Western Kenya (0° 34' 0" North, 34° 34' 0" East)	Arusha Region, (3° 20' 0" South, 35° 40' 0" East)
Elevation	1200 – 2000 m	1000 - 1900 m
Annual rainfall	1250 - 1800 mm	400 – 1200 mm
Average temperature	20-22° C in the southern part to about 5.0-10.0° C in the northern part	15 C° around the Ngorongoro forest area to 24 C° at the level of Lake Eyasi
Farming systems	subsistence agriculture with maize, sunflowers, sugarcane, coffee, tobacco, potatoes, beans and cotton while livestock include dairy cattle, sheep and goats.	subsistence agriculture with maize, beans paddy (rice), wheat, barley, beans, coffee, flowers, pigeon pea, sorghum, finger millet and sunflower; Livestock (cattle, goats, goats, sheep, chickens, pigs and donkeys.
CA practices	sub-soiler, rippers, direct seeders and jab planters; cover crops (dolichos lablab, pigeon peas)	sub-soiler, rippers, direct seeders and jab planters; cover crops, (mucuna, lablab, sun hemp, pigeon peas),

Overall, the application of QAToCA revealed a relatively high and similar adoption potential for both Bungoma and Karatu as shown by the scores for the seven thematic areas (Table:9).

Table: 9: Thematic influence on adoption potential for Bungoma and Karatu

ID	Thematic Categories	Case studies	
		Bungoma District, Kenya	Karatu District, Tanzania
A	Characteristics of CA as an object of adoption	70%	80%
B	Capacity of implementing organisation	83%	100%
C	Attributes of diffusion strategy	100%	95%
D	Political/Institutional framework at Regional Level	100%	83%
E	Political/Institutional framework at Village Level	80%	90%
F	conditions at village and regional level	60%	50%
G	Community's attitude towards CA	80%	75%

Amongst the seven themes, "attributes of scaling up or dissemination strategies (thematic area C)" received high RT scores of 100% (Bungoma) and 95% (Karatu).

The other thematic areas (A, B, D, E and G) also scored relatively high in both regions, whereas unsuitable market conditions for inputs and outputs (thematic area F) were considered as aspects exerting an outstanding negative influence on the CA adoption potential in both regions, particularly for the Karatu case study (RT score of 50%) (Table: 9).

Table: 10: Overview of supporting and hindering factors for the adoption potential.

Thematic area		ID	Indicator	Case studies	
				Bungoma Kenya	Karatu Kenya
A	CA characteristics	A01	Cost of CA and Liquidity Issue	1	1
		A02	Availability of CA knowledge	2	2
		A03	Complexity of CA	0	1
		A04	Labour requirements Vs endowments	2	2
		A05	Availability of Social networks/org.	1	1
		A06	Residue and Seeds Requirements Vs availability	0	2
		A07	Machinery + fuel requirement and availability	1	1
		A08	Land requirement and availability	2	2
		A09	Observability of CA	2	2
		A10	CA yield response and time	1	1
		A11	Relative economic risk	2	2
		A12	Trialability	2	2
		A13	Flexibility/adaptability of CA	2	2
		A14	CA and Social status + prestige of farmers	2	2
		A15	CA and conflict over resources	1	1
B	Promoting organisations	B01	Concept of Organisation	1	2
		B02	Availability and Quality of human resources	2	2
		B03	Leadership and Reputation	2	2
		B04	Organisational linkage to other CA organisations in the region	2	2
		B05	Organisational linkage with target group	2	2
		B06	Organisational linkage with stakeholders in the CA innovation systems	1	2
C	Dissemination strategy	C01	Scaling up area, target groups and characteristics	2	2
		C02	Clarity of scaling up strategy	2	2
		C03	State and level of documentation, monitoring and evaluation	2	2
		C04	Usage of established communication channels	2	2
		C05	Diffusion strategy	2	2
		C06	Compatibility of selected diffusion strategy with the target groups	2	2
		C07	Linkage of promoting organisation with farmers	2	2
		C08	Organisation and level of involvement in capacity building	2	2
		C09	Type of communication channel	2	2
		C10	Usage of incentives in the diffusion process	2	1
D	Institutional frame at regional level	D01	Political state of the region	2	2
		D02	Availability of enabling government policies	2	2
		D03	Government attitude towards CA research	2	1
		D04	State/level of administrative set up	2	1
		D05	System of administration practiced in the region	2	2
		D06	Civil society and social freedom	2	2
E	Institutional frame at village level	E01	Availability of local level governance structures	2	2
		E02	Presence of supportive local organisations	1	2
		E03	Compatibility of CA to local customs and/or norms and rules	2	2
		E04	Land access, ownership and used	2	2
		E05	Household spatial distribution and effect on CA adoption	1	1
F	Markets conditions	F01	Availability of markets to CA products	1	2
		F02	Accessibility of markets for CA produce'	1	1
		F03	Availability of basic infrastructure for CA adoption target group	0	1
		F04	Availability of interest from CA economic actors	2	1
		F05	Availability of quality control structures e.g. Certification	2	0
G	Perception of community	G01	Acceptability of CA by Community	2	2
		G02	Acceptability of CA by Village leaders/elders	2	2
		G03	Acceptability of CA by young farmers	2	1
		G04	Acceptability of CA by target group (farmers)	1	1
		G05	Social acceptability of individuals engagement in CA	2	2
		G06	Availability of a dynamic and innovative community	1	1
			Total number of factors (n)	53	53
			n Supporting factors (2)	37	37
			n Potential hindering factors (1)	13	16
			n Hindering factors (0)	3	1[5]

For the Bungoma case study, out of 53 indicators, 37 were identified as supporting (2) while 13 were classified as potentially hindering factors (1) and three as hindering factors (0) to CA adoption potential (Table: 10)

[5]Values 0, 1and 2 stands for the QAToCA scale, indicating the weight/strength of the suggested statement with respect to their influence on the potential of adoption with 2 being highest influential (maximum positive effect on adoption) and 0 being least suitable (no positive effect, possible negative effect on adoption

The indicators "complexity of CA as a practice (A03)", "residue and seeds requirements versus availability (A06)", and "availability of basic infrastructure for the CA adoption target group (F03)", were assessed to have the most severe negative effect on adoption potential (Table: 10).

For the case of Karatu, 37 indicators were observed as supporting (2) while 16 were identified as potential hindering factors (1) and one seen as hindering factor (0) to CA adoption. The absence of "quality implementation control structures (F05)" was outstandingly noted to have a negative effect on adoption potential (Table:10).

4.5 Evaluation of the QAToCA results

The QAToCA assessment for the two case studies is seen to be consistent with the actual adoption estimates on the ground. A network coordinated by FAO with qualified informants in different countries, has reveal a steadily growing movement involving already far more than 100,000 small scale farmers in the southern and eastern African region, with an adoption area of CA in Kenya and Tanzania alone amounting to over 20,000 ha (Derpsch and Friedrich 2009 , Derpsch *et al.* 2010). Following Lugandu *et al.*(2011), 61% of farmers for Tanzania and 34% for Kenya are said to be involve in the application of any one or more form of the three CA principles.

The higher adoption potential and observed estimates for the region are partly attributed to the CA dissemination strategy (C) which is positively assessed by QAToCA. This is certainly as a result of the FFS approach (Shetto and Owenya 2007) implemented in both case studies. Projects that do not involve farmers as active members in the early phases run the risk of developing technologies of little relevance and of low probability of adoption (Ashby 1987). Besides, the physical presence and influence of the ACT network within the region could possibly be the reason why the CA dissemination strategy was given a high score. Activities of the present promoting organisations in this region build on past results achieved in previous CA-related programs and on government policies, such as making tractors and animal-drawn implements, tax free for the Karatu region (Shetto and Owenya 2007). What might happen to CA adoption (like is the case with most innovations across Sub-Saharan Africa (SSA)), if such tax incentives are removed is not yet answered. Kaumbutho and Kienzle(2007) likewise highlighted the combined role of BMVEL, FAO and ACT under the CA-SARD project I and

II (2004-2010) and previous work of GTZ[6] through ACT in the institutional growth and stabilisation of the CA network for the region

That the market conditions for CA external inputs (especially specialised imported no-tillage implements for use by the farmers and their further adaptation by local manufacturers), and outlet markets for the produce of farmers (thematic area F) are negatively influencing adoption potential is also confirmed by Apina et al. (2007 pp 48) who states that "*equipment is an important aspect in technology adaptation and adoption" [….] and that… inaccessibility, unavailability and high cost of equipment for CA are the biggest hindrances to promoting and adopting the practice amongst smallholder farmers*" in the Laipiki district of Kenya. In the same study, the authors pointed out that getting seed, especially for cover crops for farmers has remained a major challenge for the promotion of CA. This closely follows the conclusions of Ndah et al. (2011) as well as Feder and Umali(1993) who call for an improvement in the marketing network and structures as preconditions for the adoption of agricultural innovations across SSA.

Competition for crop residues used as fodder, mulch and fuel has been highlighted as a challenge in both case study regions (see A15,Table:10). This challenge relates clearly to the practise of free grazing (Kaumbutho and Kienzle 2007) in most villages as livestock is allowed to graze freely on crop residues immediately after the harvesting season. A shortage in crop residues is sometimes exacerbated by prolonged dry seasons or frequent droughts which results in crop failure hence limiting crop biomass production for subsequent use as mulch, fodder and fuel. Because of a shortage in residues, farmers generally prioritise feeding their livestock than leaving the residues for mulching.

The absence of "quality implementation control structures" makes it difficult for an easy differentiation as to which farmers practise "full" CA (meaning the three CA principles are applied simultaneously) vs. which ones only partially implement CA or are just involved in some kind of CA related activities (practicing parts of CA alongside with some traditional farming practises). Diverse CA practices and project activities in both case studies partly originate from the issue of a knowledge gap (Mkomwa *et al.* 2007) with respect to the

[6]GTZis a German Organisation for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit). Since January 2011, it has become part of GIZ; the German Organisation for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit), web: http://www.giz.de/en/profile.html

implementation of the three CA principles (FAO 2008) and the fact that focus is on promoting farmer experimentation and adaptation of the technological package to suit their own circumstances (an aspect which contradicts the possibility of introducing a quality implementation structure).Mkomwa et al (2007) for example showed that CA is still seen to be new to extension staff, farmers, researchers and private agribusiness in a study in Mbeya (Tanzania). However, as the QAToCA exercise rated adoption potential high, in spite the absence of such quality structures on the ground, this consideration most certainly reflected both full and partial adoption. The conclusion of a high adoption potential for both case study regions therefore takes into account the likelihood of adoption of the three principles (FAO 2008) with the chance of partial adoption inclusive. Most often, farmers tend to adopt one or two of the CA principles as an eventual entry point to full adoption (Triomphe *et al.* 2007) once some benefits become observable (Rogers 2003).

For the case of Bungoma, the complexity of CA is the indicator exerting the most negative influence towards adoption, and regular trainings during each cropping season are needed before proper understanding of the concept of CA. Training might not even be sufficient. Authors such as Apina et al.(2007 pp 20) believe that "*CA requires a dramatic change in mentality*" for small holder farmers across SSA. This mind transformation process often does not easily happen as it requires undergoing extensive capacity building and sensitization which most farmers often see as complex to deal with. Following Rogers (2003) and Ndah(2008), once an innovation is perceived as complex and difficult to understand by farmers the chances for adoption become low.

The QAToCA results for both case study regions highlight a sense of hope with regards to future adoption of CA in the East African region.

4.6 Discussion

The QAToCA tool employs a comprehensive approach in assessing the determinants towards the CA adoption potential of a region. The tool implements the recommendations of Sumberg (2005) and Rogers (2003), by looking at the characteristics and attributes of an innovation. QAToCA also pays attention to the various stakeholders involved in the entire innovation system in two ways: 1) by assessing their influence under the different thematic categories of the tool, and 2) by selecting a mixed focus group for applying QAToCA. This reflects the concept of heterogeneity suggested by Law and Hassard (1999) and conforms with the

recommendations of the many proponents of participatory approaches (e.g. Greenwood et al. (1993), or more recently with the approaches to innovation systems (e.g. World Bank, 2006).

The QAToCA approach consisting of stratifying the determining factors into thematic areas is similar to that of the ScaLA tool (Bringe et al. (2006)for assessing the sustainability, climate relevance and scaling-up potential of project approaches,and to that of Bridges et al. (2007)in developing a qualitative assessment tool for the potential of infectious disease emergence and spread. Apart from its specific focus on CA, QAToCA differs from these other approaches in its ability to: 1) assess the adoption potential of CA, 2) determine the thematic contribution to the relative adoption potential (RT) and, 3) specifically diagnose hindering and supporting factors to the adoption potential of CA for a given case study under consideration. It further differs in its participatory implementation with a diverse focus group which allows immediate feedback to the participants.

During its application in the two case studies, most participants of the QAToCA focus groups endorse the tool based on the following perceived strengths: 1) it is easy to use and provides results instantly; 2) it is very participatory and exhaustive; and 3) it gives a quick overview of information on the CA status and adoption potential.

However, several weaknesses were raised about QAToCA such as: "*questions are too restrictive and the evaluation scale is too narrow,"* […….] and, "*the tool is compact and there is need to expand to capture all factors and opportunities and have a wider scale of evaluation".* The "restricted scale" and "compact" nature of the tool is however intentionally designed by the authors as values in the scale are linked to the answer statements. With four answer possibilities for one operational question, we assumed that a respondent(s) with background knowledge of a case study will be able to fall in at least one category. "0" responses are treated as having a "no influence" or even a "negative influence" on CA adoption potential hence all referred to as hindering factors. To this effect, in developing QAToCA, we assumed that widening the scale too much e.g. to minus, will only produce repeated or less useful results. Furthermore, having only four options to choose from for each question makes the tool less cumbersome and gives room for: 1) a quick capture of the situation; 2) quick computation of results; and 3) visualisation and feedback within one focus group discussion hence a complete iterative process, something which could not easily be achieved if the tool was made more complex. The fact that "*the assessment benefits mostly*

from discussions of opposing views and therefore the tool will not provide an in-depth understanding of the situation if used by an individual" was further pointed out as a weakness. This, in our view, is intentional since the tool was not meant to be used by a single individual, but precisely to ensure a balanced output reflecting a diversity of views.

There are further concerns with regards to the composition of a QATOCA workshop. Questions such as who should or should not be part of such a gathering so as to guarantee unbiased and reliable outcomes are still far from being satisfactorily handled (i.e. should focus be more on non CA adopters, adopters or professionals in the field?). We fully acknowledge that varying the group composition of a QATOCA exercise will equally lead to varied results. Since five participants might not be a big enough representative sample, a future guidance in this light could be to vary the participants of such a group in terms of numbers keeping the diversity and comparing the effect of this on the results for the same case study.

All together, participants of the workshops were impressed with the potential of the tool as a quick assessment guide despite its noted weaknesses.

4.7 Conclusions

The QATOCA tool, which is based on conceptual models of innovation systems, diffusion theories and relevant literature, aims at assessing a) the relative adoption potential of CA under the diverse agro-economic, socio-cultural and institutional conditions of Africa; b) the specific supporting and hindering factors to CA adoption; and c) the potential contribution of specific components within the CA innovation system towards the CA adoption potential.

QATOCA provides a relatively simple picture of the CA adoption potential which can be used as a basis for restitutions and discussions with stakeholders of the case studies in 1) providing insights into the specific CA development and diffusion programs and projects; and 2) providing entry points for planning /adjusting some of the on-going and future CA-related actions. The results can equally form a knowledge base towards the understanding of supporting and hindering factors for CA adoption under the different agro-ecological, socio-economic, institutional and cultural conditions of Africa. Nevertheless, the predictive capability of QATOCA still needs to be assessed over time, as well as its ability in identifying the specific supporting and hindering factors to adoption potential of CA. In addition, efforts

are still needed on how to best compose a focus group for a QAToCA exercise that could minimise bias judgements leading to more realistic and reliable results.

The application of the tool for Bungoma (Kenya) and Karatu (Tanzania) revealed market conditions for CA inputs and outputs (thematic area F) as outstandingly hindering adoption potential of CA. This is specifically mirrored through the need for 1) accessibility of markets for CA products; 2) inputs, such as legume seeds and adapted CA machineries; 3) basic infrastructure for CA adoption target group, such as farms to market roads; 4) introduction of quality CA implementation measures; and 5) a renewed motivation and interest amongst CA service providers. However, a close look at the determinants, reveal a certain dominance of supporting over hindering factors with a heavy presence of promoting institutions (especially for Bungoma case) positively influencing the CA adoption potential.

Nevertheless, a sustained scaling up in CA adoption could mostly be witnessed if concerted efforts are made towards improving on the needed basic infrastructures for CA adoption such as market access and roads, credit facilities and adapted CA equipment for this region.

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CHAPTER 5

ADOPTION POTENTIAL OF CONSERVATION AGRICULTURE PRACTICES IN SUB-SAHARAN AFRICA: RESULTS FROM FIVE CASE STUDIES

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5 Chapter 5: Assessing adoption potential of CA in SSA

5.1 Abstract

Despite the reported benefits of Conservation Agriculture (CA), its wider up-scaling in Sub-Saharan Africa (SSA) has remained fairly limited. In this paper we show how a newly developed Qualitative expert Assessment Tool for CA adoption (QAToCA) was applied to determine adoption potential of adapted CA practices in Burkina Faso, Malawi, Zimbabwe and Zambia.

The potential for CA adoption is not a predictor of observed adoption rates. Instead, our aim was to systematically check relevant factors that may be influencing its adoption. QAToCA delivers an assessment of how suitable conditions "and thus the likelihood for CA adoption" are. Results show that the high CA adoption potentials exhibited by the Malawi and Zambia case relate mostly to positive institutional factors. On the other hand, the low adoption potential of the Zimbabwe case, in spite of observed higher national figures, is attributed mainly to unstable and less secured market conditions for CA inputs and outputs. In the case of Southern Burkina Faso, the potential is assessed high and deviates from lower observed figures. This is attributed mainly to strong competition of CA and livestock for residues in this region. Lastly, the high adoption potential found in Northern Burkina Faso is explained mainly by the fact that farmers here have no alternative than to adopt a locally well adapted CA system (Zaï farming).

Results of this assessment should help promoters of CA in the given regions to reflect on their activities and to eventually adjust or redesign them based on a more explicit understanding of where problems and opportunities are found.

5.2 Introduction

Africa's population continues to grow at higher rates (3% per annum) (Pay et al. 2001) compared to crop yields and food production, which are currently stagnating (Pretty et al. 2011). Overall, average cereal grain yields in African countries are not more than 1 ton/ha, far less than the levels needed to achieve the Millennium Development Goal 1 (WHO 2012). Depleting soil fertility caused by extractive and exploitative farming methods is among the fundamental causes of such low yields (Sanchez et al. 1997). In particular, continued cropping without sufficient inputs of nutrients and organic matter leads to extensive soil degradation (Tittonell and Giller 2012). As in other parts of the world, small-scale farming in Africa faces a double challenge: increasing production while at the same time preserving natural resources (Pretty 2008; Tilman et al. 2002). While conventional agriculture based on intensive tillage practices (Hobbs 2007) is believed to induce soil erosion with associated nutrient loss (Thiombiano and Meshack 2009), Conservation Agriculture (CA) is increasingly seen as a promising alternative for practicing productive and sustainable farming (Kassam and Friedrich 2011).

Conservation Agriculture relies on the simultaneous application of three basic principles: 1) minimum soil disturbance or no-tillage, 2) permanent soil cover and 3) diversified crop rotations or associations (FAO 2008). Although these principles have wide-ranging applicability, the techniques and technologies necessary to implement them need to be specifically adapted according to site-specific agro-ecological, socio-economic and cultural conditions (Erenstein et al. 2012).

Despite its associated benefits and the many efforts devoted to its promotion, CA is not yet widely adopted[8] by small-scale farmers throughout Sub-Saharan Africa (SSA)—with only an estimated 368,000 ha, compared to other continents (e.g., South America—with 55,630,000 ha) (Kassam and Friedrich 2011; Kassam et al. 2009). Although several studies exist on constraints to CA adoption in SSA (Baudron et al. 2005; FAO 2008; Giller et al. 2009), a concise summary of the regional and site-specific adapted CA practices has not been done and there is no clear explanation why there is still a lag in the wider adoption of these practices..

[8] Adoption is the decision to make full use of an innovation as the best course of action (Rogers 2003).

Although some studies have attempted to identify driving and hindering factors for CA adoption in selected case studies, this has been done with little consideration of the case studies' context (Baudron et al. 2005; Bolliger et al. 2005). The CA adoption process in most studies has not been treated as a joint learning process in which agents interact at multiple sectors and scales, creating multiple information flows (Erenstein et al. 2012).

As an attempt to bridge this knowledge gap, this paper demonstrates how a newly developed approach (Qualitative expert Assessment Tool for CA adoption—QAToCA) (Ndah et al. 2012) was used to assess the adoption potential of site=specific CA practices across SSA.

Specifically, the paper: 1) first highlights the background and nature of selected adapted CA practices in five case studies across SSA as introduced on the ground; 2) assesses the adoption potential of these CA practices; 3) analyses the institutional, socio-economic and cultural influences on the adoption potential of these practices; and 4) diagnoses the site-specific hindering and supporting factors of the CA adoption process in the respective case study areas across SSA. In addition to these listed objectives, the paper is guided by the following hypotheses: i) that the adoption potential of CA practices across SSA will vary among case study regions and ii) that QAToCA is an appropriate method to differentiate the adoption potential of CA across regions in SSA.

5.3 Materials and methods

5.3.1 Description of approach

The study described in this paper was conducted in five case studies spread across Burkina Faso, Malawi, Zambia and Zimbabwe. Noting that the implementation of CA differs from region to region across SSA, it is a multi-site assessment which focuses on the three CA principles, which are implemented differently on the ground. Although the CA principles are defined as common to CA systems, the actual implications vary substantially across agro-ecosystems and farmers. It should also be noted that the use of 'adoption' of CA in the context of this paper takes into consideration full adoption of the three principles as well as partial adoption (i.e., only one or two of the three principles).

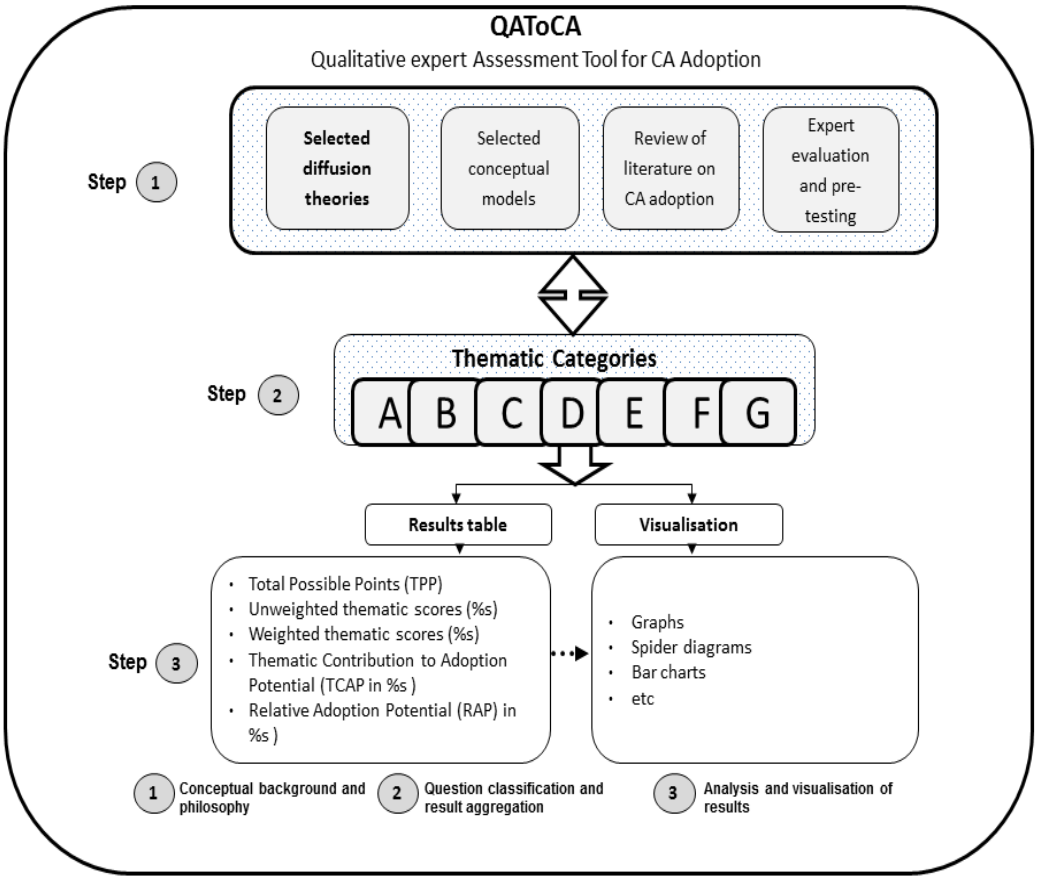

Figure 6: Conceptual background and development steps of QAToCA approach

The QAToCA approach (Ndah et al. 2012), based on selected diffusion theories of innovations (Hoffmann 2006; Hruschka 1994; Lewin 1943; Rogers 2003; Triomphe et al. 2007) and conceptual models of innovation systems (Law and Hassard 1999; World Bank 2006) (see also Figure 6) was used for this assessment.

Developed as a self-assessment tool, this approach focuses on supporting the activity of regional experts, research teams and managers of development projects with a focus on CA, by enabling them to assess the relevance and orientation of on-going CA efforts along a systematic list of questions and criteria. The tool allows for an assessment of the relative CA adoption potential in different regions, and for diagnosing the supporting and hindering factors of CA adoption in a given case study.

The conceptual background and development steps of the tool include: (i) a review of adoption theories and conceptual models of innovation to identify relevant factors in the CA

adoption process; (ii) the development of operational questions, assessment indicators and answer statements; and (iii) the development of the computer-based tool, including pre-testing (Figure 1). These steps also reflect the pathway through which data is captured, analyzed and visualized using the approach (see step 2 and 3, Figure 6).

Questions tackled by the tool are structured into seven (A to G) thematic areas as follows: (A) characteristics of CA as an object of adoption; (B) capacity of promoting organizations, (C) attributes of diffusion strategy; (D) institutional frame conditions at the regional level; (E) institutional frame conditions at the village level; (F) market conditions at the village and regional levels; and (G) the community's perception at the village and regional levels. Underpinning each of these categories are specific operational questions which address the particular situation under each theme.

In total, the tool comprises 53 operational questions which are each linked to one assessment indicator. Each of the indicators is in turn linked to three possible pre-formulated answer statements with scores of 0, 1 and 2 respectively. The order of the statements, and the resulting scoring associated with choosing each of them reflects their relative assumed influence on the adoption potential (from highest positive influence—with a score of 2, to negative influence—with a score of 0). The users of the approach have to assess which of these statements applies best in the region under consideration. Scores are aggregated for each category (A-G), as specified in equation 1, to identify which of these areas is potentially responsible for the state of CA adoption potential in a given study area.

$$RT_x = \frac{\sum_{i=1}^{n} a_i}{n * \mathrm{A\,max}} * 100 \qquad \text{(equation 1)}$$

with

RT–relative adoption potential for thematic area x (in %)

n–total number of operational questions in thematic area x

a_i–value (2, 1, 0) corresponding to the answer statement selected for operational question i

A_{max}–maximum possible value (2) for operational question i

The QAToCA tool is applied by filling out an Excel spreadsheet based on the answers provided by several experts for one case study, using a workshop-like meeting and adopting a participatory approach (Greenwood et al. 1993). With the assumption that no expert has knowledge about all levels considered in the tool, the best selection composition and criteria for such a focused group workshop should include a diversity of stakeholder representatives: researchers; extensionists/promoters of CA; farmers with appropriate CA knowledge (adopters); farmers who have adopted CA but stopped practicing it or who considered adoption but then did not implement it (non-adopters); and if possible, service providers (agro-business dealers). This group is guided through the questions by a facilitator who has good knowledge of the tool and provides enough time for thorough discussions among the participants (approx. half a day to one day). Discussions are documented, reflecting the diverse opinions within the group if they arise. Based on these recommendations (Ndah et al. 2012), the tool was applied during the second half of 2011 to assess the CA adoption potential in SSA.

5.3.2 Selection and location of case studies

The five case study areas are spread across four countries in western and southern Africa (Figure 7) and present contrasting conditions vis-à-vis adoption. The case studies focused on cereal growing areas in sub-humid regions.

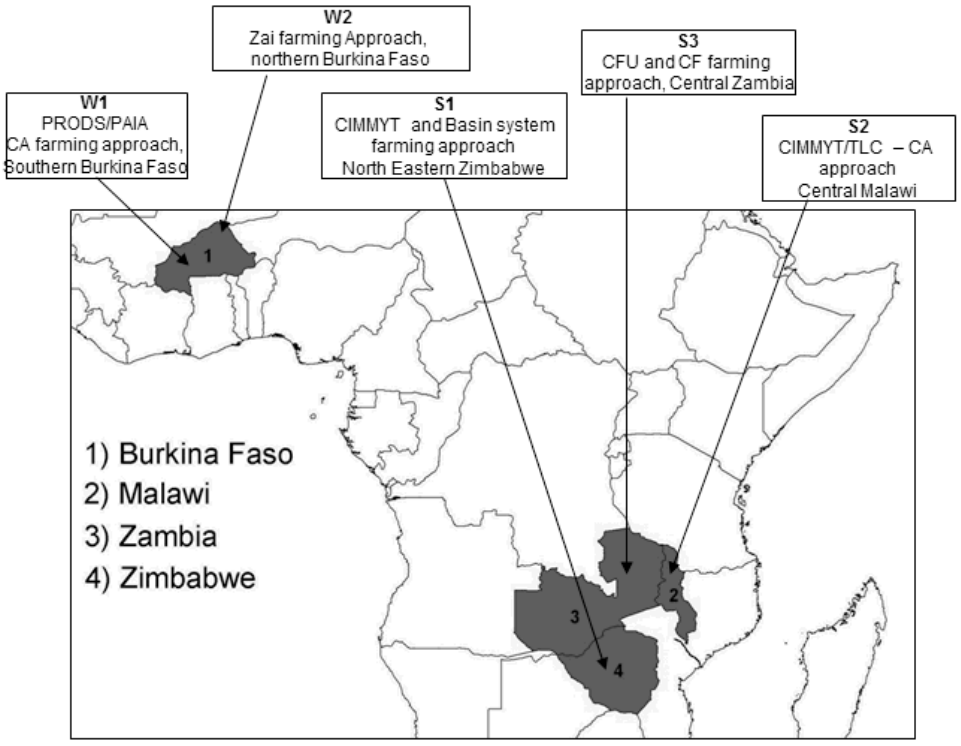

Figure 7: Location of case study areas

The selection criteria were based on a number of factors such as 1) on-going CA projects in the regions and 2) areas reflecting a diversity of situations vis-à-vis the *dynamic and innovative nature*[9] of the respective CA systems (Erenstein et al. 2012). This diversity included the type of farming systems, the diverse agro-ecological zones, the type of CA practices and the involvement of a CA promoting organization (Table: **11**); furthermore, the possibility for a quick survey using the QAToCA tool was also taken into consideration. In the following section, we give a detailed description of the case study areas and respective CA practices as implemented in the ground.

5.4 Case studies and CA practices as implemented on the ground

Because of the huge diversity of farming systems in SSA, the techniques and technologies to put the CA principles into practice vary widely, and diverse types and levels of adoption can be found. In general, CA adoption by farmers follows a step-by-step approach starting with: 1) a site specific adaptation of the technology to suit the regional context; 2) adoption of the adapted practices, which in most cases consist of one or two of the recommended three principles by the Food and Agricultural Organization (FAO); and lastly, 3) a full adoption of the complete package with all three principles observed–an ideal situation fitting only a few farmers in most parts of SSA currently. A majority of farmers in SSA seem to fall under step two. In this paper, however, the intention is not to distinguish the levels or types of adoption but to assess the adoption potential of site-specific adapted practices (step two). To do this in a logical way, we first highlight the diverse case study backgrounds revealing the diverse CA practices (Table: 11) in the respective cases, as follows:

5.4.1 Southern Burkina Faso—PRODS/PAIA CA approach (W1)

Case W1 is located in the moist savanna region of southern Burkina Faso, 110 km from Bobo-Dioulasso. The majority of soils in this region are weathered ferruginous tropical soils, (Ultisols, FAO taxonomy). They have a sandy to sandy-loam texture and are fragile in structure with an acidic pH and low organic matter content (Zida 2011).

[9] CA adaptation and adoption process is most efficient when local "innovation systems" emerges and begin to acquire a self-sustaining dynamics

Because of population pressure, the fallow practice which used to restore soil fertility has been abandoned (Traore 2006). Only small amounts of mineral fertilizers are used on cropland (INERA 2003). As a consequence, crop yields are decreasing. The main cropping system is cotton in rotation with maize and sorghum (Table 1). Most farms can be characterized as mixed crop-livestock systems with variable numbers of livestock species (cattle, goats and sheep). During the dry season, cereal crop residues are typically grazed by ruminant herds.

To reverse the adverse situation of declining soil fertility, FAO, INERA and the cotton farmers' organization (UNPCB) launched the PRODS/PAIA project in 2004 (Kassam et al. 2010). PRODS/PAIA is *"aconcept of integrated agricultural production systems (PRODS) as a priority for interdisciplinary actions (PAIA) approach*" (Kassam et al. 2010 pp iv). Field activities for the project included adapting and testing technologies for crop diversification and intensification. These involved development of fodder production as well as further adaptation and application of the three CA principles. Specifically, CA as promoted under the PRODS/PAIA project applies two approaches:1) horizontal integration—which seeks to promote no-till based farming, crop diversification, rotation, soil cover with plant residues and 2) vertical integration—which seeks to improve yields through processing, marketing and distribution to further improve the added value. Active farmer involvement was sought by adapting the "Farmer Field School" approach for "Integrated Production and Pests Management" (FFS[10]-IPPM) (Kassam et al. 2010).

5.4.2 Northern Burkina Faso—Zaï practice (W2)

Case W2 covers the towns of Yatenga, Yoka, Dosin and Bokin (northern Burkina Faso) (Table 1) in the Sahelian region. The dominant soils in this area are Aridisols, characterized by a low concentration of organic matter and acidic pH. This reflects the limited vegetative cover with water deficiency as a major defining characteristic. Crop yields (mostly sorghum and millet) in this region are, therefore, limited by both water and nutrient availability (Stroosnijder and Rheenen 2001). Frequent droughts (especially in the 80s and 90s) and inappropriate use of natural resources in this area have destroyed the vegetative cover, exposing soils to wind and water erosion (Roose et al. 1999; Traore 2006), which has

[10] The Farmer Field School (FFS) is a group-based learning process that has been used by a number of governments, NGOs and international agencies to promote Integrated Pest Management (IPM)

ultimately resulted in bare and indurated soils, locally called zipellé. In response to these conditions, the "Zaï" system was introduced in this region (Ouedraogo and Bertelsen 1997; Roose et al. 1999). The Zaï technique is an indigenous practice that originated in the Dogon region in Mali. Its initial introduction and adaptation in Burkina Faso originated from the personal efforts of a few innovative farmers after the droughts of the 80s, while NGOs, public and private sector projects as well as international bodies (e.g., World Bank, IFAD OXFAM, etc.) assisted in scaling up its dissemination.

Table: 11: Case study description

	Western Africa (W)		**Southern Africa (S)**		
	Case W1	**Case W2**	**Case S1**	**Case S2**	**CASE S3**
Case study area and country	Southern Burkina Faso	Northern Burkina Faso	South and Southwest, Zimbabwe	Central region, Malawi	Central region Zambia
Project or approach	PRODS/PAIA	Zaï planting pits system	CIMMYT and Basin system approach	TLC/CIMMYT-CA	CFU farming approach
Coordinates location	Latitude 11° 12' 0" N and longitude 4° 18' 0" W	Latitude 12° 58' 0" N and longitude 1° 51' 0" W	Latitude 17° 45' 0" S and longitude 31° 19' 60" E	Latitude 13° 34' 60" S and longitude 34° 0' 0" E	Latitude 15°46' 0" S and longitude 27°55' 0" E
Elevation	430m	350m	1292m	1079m	1008m
Period of CA promotion	2002-2010	1980-2003	2006- ongoing	2006-ongoing	1980s-onging
Precipitation	800-1000mm	400-700mm	550-900mm	700-1100mm	700-1500mm
Farming systems	Crops: cotton, maize, sorghum, cowpea, peanut, pigeon pea, cassava, soybean Livestock: cattle, sheep, goats, chicken, guinea fowls	Crops: sorghum and millet Livestock: cows, oxen, sheep, goats, chicken, donkeys, horses, camels	Crops: maize, cotton, cowpea, soya beans, pearl millet, sunflower, groundnut Livestock: cattle, oxen, goats	Crops: groundnuts, cowpea, cotton, maize Livestock: cattle, goats, sheep, pigs, chickens, ducks, donkeys	Crops: maize, cotton, sorghum, millet, cassava, beans, pumpkins, watermelons and cucumber Livestock: cattle, goats, pigs and poultry
CA practices	Minimum tillage or no till and crop rotation	Planting pits (Zaï) (minimum tillage)	Intercropping and some crop rotation or associations	Minimum tillage, maximum ground cover, rotation and association	Mostly minimum/zero tillage practices but introduction of rotation, soil cover, and agroforestry
Phase of project	Adaptation and Scaling up	Adaptation and Scaling up	Development	Adaptation and Scaling up	Adaptation and Scaling up
Main promoting organizations	FAO, INERA, farmers organization UNPCB	IFAD, OXFAM, World Bank, GTZ (GIZ), USAID and other NGOs	River of Life, ICRISAT, World Vision, Care International, ZCATF, FAO, CARITAS, and many other NGOs	TLC, Min. of Agriculture, CIMMYT, FIDP; CU, NASFAM and FICA	CFU, GART, ZNFU, Dunanvant, CLUSA, LM & CF, MACO

Notes

Case W1: PRODS/PAIA approach, southern Burkina Faso
Case W2: Zaï planting pit system, northern Burkina Faso
Case S1: CIMMYT and basin system approach, northeastern Zimbabwe
Case S2: TLC/CIMMYT-CA approach
Case S3: CFU farming approach, Kafue, Central Zambia

Acronyms

CIMMYT	International Maize and Wheat improvement Center (Centre International de Mejoramiento de Maiz y Trigo)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ZCATF	Zambian Conservation Task Force, Zimbabwe Conservation Agriculture Task Force
CFU	Conservation Agriculture Unit
TLC	Total Land Care
GTZ	German Organization for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit)
CARITAS	Congregation Around Richmond Involved to Assure Shelter
NASFAM	National Small Farmers Association of Malawi
FICA	Flemish International Cooperation Agency
MACO	Ministry of Agriculture and Cooperation, Zambia
CLUSA	Cooperative League of the United States of America
IFAD	International Fund for Agricultural Development
OXFAM	Oxford Committee for Famine Relief
INERA	National Research Institute for Agriculture and Environment (Institut National de l'Environnement et la Recherche Agronomique)
UNPCB	National Union of Cotton Producers, Burkina Faso (Union, Nationale, Producteurs, Coton, Burkina, Faso)
USAID	United Sates Agency for International Development
FAO	Food and Agricultural Organization
FIDP	Farm Income Diversification Programme
GART	Golden valley Agricultural Research Trust
NGOs	Non-Governmental Organizations
PRODS/PAIA	Integrated Agricultural Production Systems (PRODS) as a Priority for Interdisciplinary Actions (PAIA)

The Zaï technique involves a series of man-made pits, 10-20 cm deep and 20-30 cm wide which concentrate rainfall and surface water run-off (Roose et al. 1999; CGIAR Group 2011; IFAP 2005). Traditionally, organic matter (mostly from animal dung) is added to each pit which is then covered with a thin soil layer (IFAP 2005). The principle is straightforward: rather than spreading nutrients and water uniformly over the field, they are concentrated in the pits to maximize crop yield for a given level of inputs. The planting pits are best maintained by other crop/soil management practices such as using crop residues against topsoil loss and enriching the soil with nutrients. Since this practice involves a systematic distribution of pits without complete disturbance of the entire field, we argue that this meets the minimum tillage principle of CA. Improved Zaï systems can, therefore, be seen as an adapted CA practice.

5.4.3 Northeastern Zimbabwe-CIMMYT CA approach (S1)

Case S1 covers the districts of Goromonzi and Murehwa in northeastern Zimbabwe (Mashonaland, Eastern Province). Both districts are located in Natural Region II (Vincent and Thomas 1960), receiving 750-1000 mm annual rainfall in a uni-modal pattern between December and April but with the frequent occurrence of dry-spells (Zvigadza et al. 2010). Mixed crop-livestock farming dominated by maize and horticultural activities is the main farming enterprise in both districts. Cattle ownership varies widely among households. In the dry season, most crop fields are used for cattle grazing, and cattle eat crop residues to complement the poor quality grazing that remains in the surrounding rangelands. Dominant soils in the region are granite-derived sandy soils (Luvisols, FAO 2013) of low inherent fertility (Grant 1981; Nyamangara and Mpofu 1996). Due to increasing population pressure, land sizes per household have continued to dwindle over the years along with increased soil erosion and land degradation, resulting in poor productivity under maize monoculture, especially in the fields furthest away from homesteads. These fields are characterized by nutrient deficiencies, high acidity, low soil organic carbon and low water holding capacity (Zingore et al. 2007).

It is against this background that in the late 80s, an adapted CA practice called “basin tillage” (Nyagumbo 2008; Sims et al. 2012; Twomlow and Hove 2013) was introduced in the region. The basin tillage concept was first developed by Brian Oldrieve in Zimbabwe in 1993. It is a modification of the traditional pit systems once common in southern Africa. It is also a

variation of the Zaï pit system (Roose et al. 1999) with a smaller pit size: 15 cm wide by 15 cm deep (Andersson and Giller 2012; Erenstein et al. 2012; Twomlow and Hove 2013). The basins are dug in the dry season and half-filled with organic manure or dressed up with inorganic fertilizers and then lightly covered with soil (Johansen et al. 2012). In addition, farmers are encouraged to spread whatever crop residues might be available as a surface mulch to prevent soil losses early in the season, conserve moisture later in the season, and enrich the soil with nutrients and organic matter as the residues decompose. Planting starts in November/December immediately after water collection with the first rains (Twomlow and Hove 2013). This practice is generally referred to as 'conservation farming' by the farmers and promoters. It spreads labor for land preparation over the dry seasons and encourages timelier planting, resulting in reduction of peak labor loads at planting. Since 2004, this practice, now labeled "basin system", has been intensively promoted by NGOs and other international organizations, e.g., FAO, especially under the Zambian Conservation Task Force (ZCATF)[11] programme (Twomlow et al. 2008).

5.4.4 Central Malawi—TLC/CIMMYT CA approach (S2)

Case S2 covers the Nkotakota and Lilongwe districts of Central Malawi. The climate is sub-tropical with two successive seasons (i.e., a rainy season from November to May and a dry season from May to November). Annual average rainfall varies from 700 mm to 1,100 mm (Table 1). Soils are mostly loamy sands, moderately acidic with low to sufficient nutrient levels (Snapp 1998). The dominant soil types found in both communities are Luvisols, Lixisols and Cambisols (Thierfelder et al, 2013). Maize is the main food crop grown in all districts, often in a monoculture, but sometimes intercropped with pigeon peas (Cajanus cajan L. Millsp) and cowpeas (Vigna unguiculata L. Walp). Traditional farming practices involve the clearing and burning of weeds followed by the construction of planting ridges using a hand hoe. This is a rather labor-intensive practice, since ridges from the previous growing season are dug and moved into the existing furrow to make new ridges (Bunderson et al. 2007). Ridging has been promoted since colonial times as the main method of controlling soil erosion. When prepared along the contour, ridges prevent the destructive effect of excessive

[11] ZCATF—A broad task force led by FAO in 2004 which consisted of four major principles: (i) high management standard; (ii) minimum tillage; (iii) precision application of small doses of nitrogen-based fertilizer to achieve higher nutrient efficiency; and (iv) combination of improved fertility with improved seed for higher productivity.

runoff by holding rainwater and giving it time to infiltrate into the soil. Ridging breaks up the soil and temporarily improves porosity and plant growing conditions until the soil consolidates and settles back. With continued and intensive cultivation of land under conventional agriculture, soils progressively lose quality, and if not replenished, nutrient levels diminish with subsequent drops in crop yields. Continued use of the hand hoe leads to formation of hard pans which impede both water infiltration and plant root penetration, hence making plants vulnerable from the water stress. Additionally, ridges can enhance effects of soil erosion if they do not run along the contour (Bunderson et al. 2007; Thierfelder et al. 2013).

It is against this background that CA was introduced in the late 90s mainly through Sassakawa Global 2000 (Ito et al. 2007; NCATF 2012). CA as promoted by the National CA Task Force of Malawi (NCATF) involves managing crop residues on the soil surface with no-tillage, adopting high maize plant density, fertilizer use and the use of herbicides as the preferred option for weed control (Irish Aid 2011; Ngwira et al. 2012b). Conservation Agriculture practices are translated as "ulima wa mtaya khasu" in Chichewa[12] language, which literally means "farming without hoes" or "farming where hoes are thrown away" (Irish Aid 2011; Ngwira et al. 2012a). NCATF of Malawi led by FAO, Total Land Care (TLC) and CIMMYT are the main promoting organizations (Mloza-Banda and Nanthambwe 2010) alongside other NGOs (Table 1).

5.4.5 Central region of Zambia—CFU CA approach (S3)

Case S3 covers the area of Kafue, 41 km south of Lusaka (Zambia). It falls in the agro-ecological region IIa of Zambia, characterized by a mono-modal rainfall pattern (rains from November to March) and receives annual rainfall of between 800 and 1,200 mm (Table 1). The soils are loamy-sandy or sandy Alfisols, and are comparatively fertile in relation to most parts of the country (Haggblade and Tembo 2003). The area suffers from moisture stress during dry years and witnesses periodic scattered rainfall even in years of adequate overall rainfall (Haggblade and Tembo 2003). Maize is the predominant staple food crop among others such as cotton, sorghum, millet, cassava, beans, pumpkins, watermelons and cucumber. Intensive tillage and the common practice of burning residues in this area have been perceived as major causes of soil degradation and continuous decline in crop yields.

[12] Malawi's national language

In the late 80s, the Zambian National Farmers Union (ZNFU) gained initial interest in minimum tillage (Johansen et al. 2012; Sims et al. 2012) and the first trials were carried out in 1995 at the Golden Valley Agricultural Research Trust (GART) (Baudron et al. 2007). In 1996, the Conservation Farming Unit (CFU) was formed and alongside GART, has been leading the wide scale promotion of CA. For hand hoe farmers, CA revolves around dry-season preparation of a precise grid of permanent planting basins (between 15,700 and 19,000 basins per hectare depending on the inter-row spacing). For farmers using oxen, CA technology involves dry-season ripping, normally with the locally developed Magoye Ripper. The CFU approach to CA recommends that farmers apply the following five components simultaneously: 1) retention of at least 30% of the crop residue with no burning; 2) minimum surface tillage without soil inversion; 3) land preparation—during the dry season to break the plough pan as well as immediately after harvest to prepare the seedbed for the following season; 4) creation of a precise and permanent grid of planting stations, furrows, pits, trenches or ridges on the contours; and 5) rotation with nitrogen-fixing legumes of at least 30% of the cropped area (Aagaard 2011, unpublished; Baudron et al. 2007).

5.5 Results

In each of the five case studies, a one day QAToCA multi-stakeholder workshop was conducted during the second half of 2011. The selection of key informants and farmers for these workshops was based on their knowledge of the case studies under consideration as well as their involvement in the on-going CA adaptation efforts (except for the skeptical farmers). On average, 10 participants took part in each workshop: composed of two CA experts, two CA farmers (adopters), two non-CA farmers (non-adopters), two service providers and two extension workers; all of the participants were from the respective case study region. This section presents the results obtained from the QAToCA assessment grouped under: 1) West Africa, 2) southern Africa and 3) overall supporting and hindering factors towards CA adoption potential in SSA.

5.5.1 Adoption potential of CA practices and thematic categories for West Africa

QAToCA assessment for West Africa portrays the two case studies (southern Burkina Faso-W1 and northern Burkina Faso-W2) as having a relatively high and similar CA adoption

potential (Figure 8).

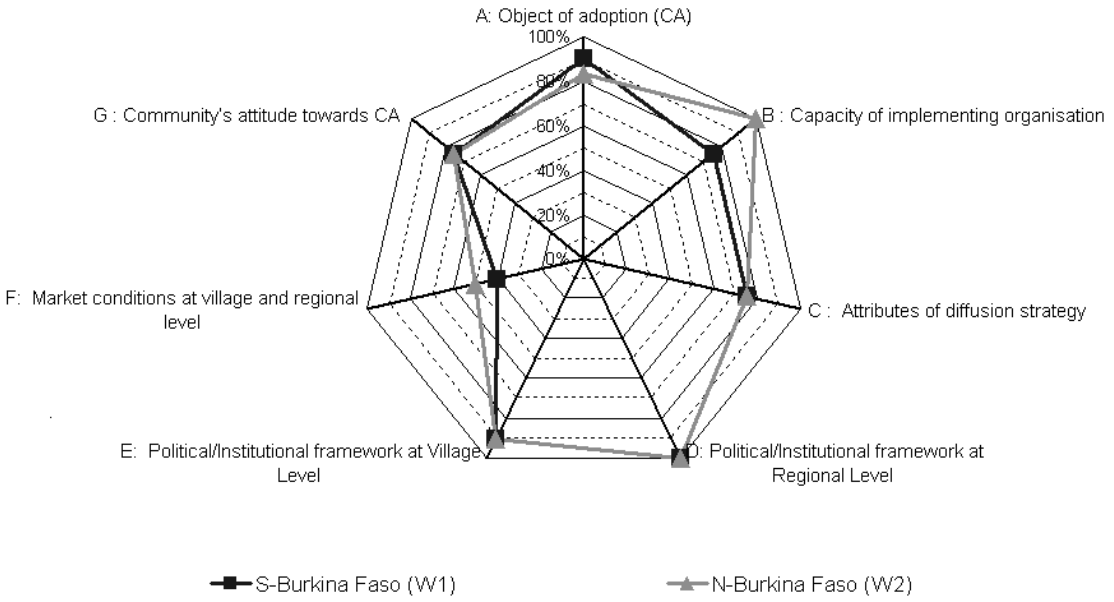

Figure 8: CA adoption potential and thematic influence for Western Africa

Notes: **figures in percentages (%) represent the RT Scores. The higher the percentage (e.g., 100%) implies a stronger positive influence on adoption potential and vice versa.**

There is a high variation at the capacity level of the implementing organization (B) with a 100% and 75% RT score for southern and northern Burkina Faso, respectively. Political and institutional frame conditions at the regional level (D), on the other hand, show a very high and equal positive influence on the CA adoption potential for both case studies with a 100% RT score each (Figure 8).

Nevertheless, market conditions for CA inputs and outputs[13] (F) showed the most negative influence on adoption potential for both cases with a 40% and 50% RT score for northern and southern Burkina Faso, respectively.

[13] "*CA inputs"* includes all adapted tools, machineries, herbicides, seeds, etc., required for the CA farming process while *"CA outputs*" include all harvested yields from the CA field at the end of the farming season, e.g., grains, tubers, legume seeds, fruits, etc.

5.5.2 Adoption potential of CA practices and thematic categories for southern Africa

For southern Africa (Zimbabwe-S1, Malawi-S2, Zambia-S3), QAToCA results show an uneven variation in the CA adoption potential. Generally, Malawi has a relative high adoption potential, followed by Zambia and Zimbabwe (Figure 9).

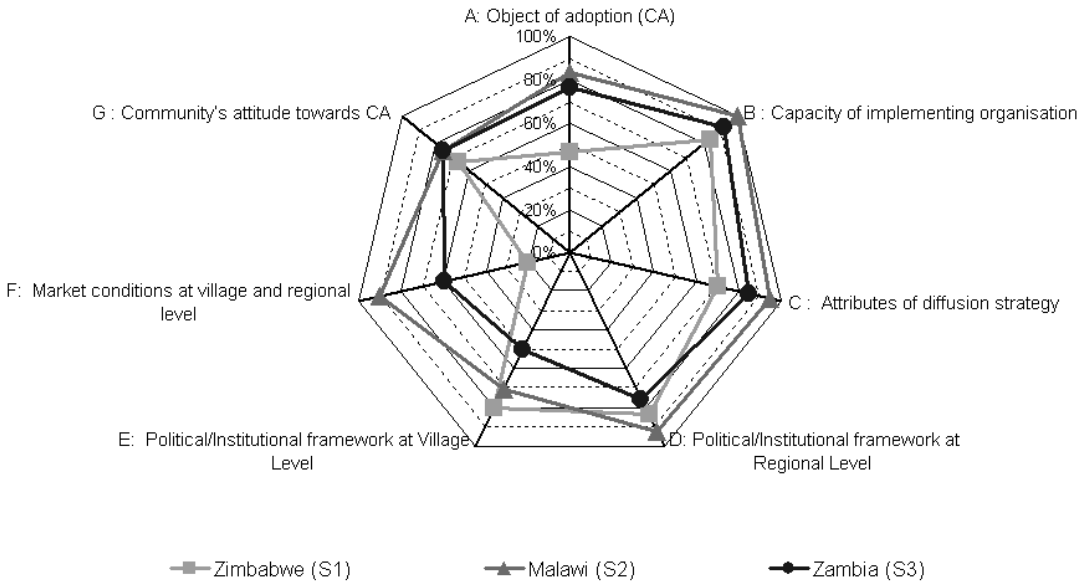

Figure 9: CA adoption potential and thematic influence in Southern Africa case studies

Notes: *figures in percentages (%) represent the RT Scores. The higher the percentage (e.g., 100%) implies a stronger positive influence on adoption potential and vice versa.*

Further variation occurs in relation to the influence of the various thematic categories (A-G). While market conditions for CA inputs and outputs (F) are among[14] the categories that have a very strong positive influence on adoption potential for Malawi (RT 90%), the results show this category is the most negatively influential one for Zimbabwe (RT 20%) (Figure 9). In addition, while CA characteristics as an object of adoption (A) appear to be positively influencing the CA adoption potential for Malawi and Zambia (RT 83% and 76% respectively), the same thematic category exerts a negative influence in the case of Zimbabwe (RT 46%). The political and institutional frame conditions at the village level (E) are the main

[14] In addition, farmers often acknowledge labor savings, higher yields, moisture conservation, etc. as some of the drivers of adoption.

positively influential category (RT 80%) for Zimbabwe, though with a much lower influence in Zambia (RT 50%) and Malawi (RT 70%) (Figure 9).

The categories: (B) capacity of promoting organization, (C) attributes of dissemination strategy, (D) political and institutional frame conditions at regional level and, (G) the community's attitude towards CA are all assessed through QAToCA as exerting a positive influence on the CA adoption potential for Zambia, Malawi and Zimbabwe.

5.5.3 Overview of supporting and hindering factors for adoption potential of CA

Table: 12 shows a more detailed overview of supporting (score = 2) and hindering (score = 0) factors for the adoption potential of CA across the five case study regions. While Malawi emerges at the top with the most supporting factors (40 out of 53 indicators), the Zimbabwe case shows the most hindering factors (11 out of 53) (Table: 12). More specifically for southern Africa, residue and seed requirements vs. availability, flexibility in adapting CA tools and machinery, type of communication channels and availability of quality control structures were all identified as the main hindering factors to CA adoption potential, especially in the case of Zimbabwe. In addition, CA costs, the liquidity issue, CA complexity, CA network availability, CA input and output market conditions and limited CA acceptance by young farmers were identified as the main hindering factors for both Zimbabwe and Zambia (Table: 12). Lastly, the level of administrative set up was seen as a hindering factor for Zambia, while the issue of land access, ownership and use was identified as a main hindering factor for both Malawi and Zambia (Table: 12).

For West Africa, the availability of quality control structures was identified as a major hindering factor for the southern Burkina Faso case study. On the other hand, the limited availability of social networks for CA and absence of markets for CA products were identified as main hindering factors to CA adoption potential especially in the case of northern Burkina Faso (Table: 12).

Table: 12: Overview of supporting and hindering factors for adoption potential

Thematic area		ID	Indicator	Case Studies				
				S3	S2	S1	W1	W2
A	Characteristics of CA as an object of adoption	A01	Cost of CA and liquidity issue for CA adopting farmers	0	1	0	1	2
		A02	Availability of CA knowledge within the adopting community	1	1	1	2	2
		A03	Complexity of CA as perceived by farmers	0	2	0	1	2
		A04	Labor requirements vs. endowments within the adopting community	2	2	1	1	2
		A05	Availability of social networks/organization within adopting community	0	1	0	1	0
		A06	Residue and seed requirements vs. availability	2	1	0	2	1
		A07	Machinery + fuel requirement and availability	2	1	0	2	2
		A08	Land requirement and availability	2	2	2	2	2
		A09	Observability of CA as a new innovation	2	2	2	2	2
		A10	CA yield response and time	2	2	2	2	2
		A11	Relative economic risk	2	2	2	2	2
		A12	Trialability of CA as a new innovation	2	2	1	2	2
		A13	Flexibility/adaptability of CA	2	2	0	2	2
		A14	CA and social status + prestige of farmers	2	2	2	2	2
		A15	CA and conflict over resources	2	2	1	1	2
B	Nature of CA promoting Organization	B01	Concept of promoting organization	2	2	1	2	2
		B02	Availability and quality of human resources	2	2	2	2	2
		B03	Leadership and reputation within the organization	2	2	1	2	2
		B04	Organizational linkage to other CA organizations in the region	2	2	2	2	1
		B05	Organizational linkage with target group	2	2	2	2	1
		B06	Organizational linkage with stakeholders in the CA innovation systems	1	2	2	2	1
C	Dissemination Strategy of the promoting organization	C01	Scaling up area, target groups and characteristics	2	2	1	1	1
		C02	Clarity of scaling up strategy	2	2	1	1	1
		C03	State and level of documentation, monitoring and evaluation	1	2	2	2	1
		C04	Usage of established communication channels	1	2	2	1	1
		C05	Diffusion strategy of the organization	2	2	2	2	2
		C06	Compatibility of selected diffusion strategy with the target groups	2	2	2	1	2
		C07	Linkage of promoting organization with farmers	2	2	2	2	2
		C08	Organization and level of involvement in capacity building	2	2	1	2	2
		C09	Type of communication channel	1	2	0	1	1
		C10	Usage of incentives in the diffusion process	2	1	1	2	2
D	Institutional frame conditions at regional level	D01	Political state of the region	2	2	2	2	2
		D02	Availability of enabling government policies	2	2	1	2	2
		D03	Government attitude towards CA research	2	2	2	2	2
		D04	State/level of administrative set up	0	2	2	2	2
		D05	System of administration practiced in the region	1	2	2	2	2
		D06	Civil society and social freedom	2	1	1	2	2
E	Institutional frame conditions at village level	E01	Availability of local level governance structures	2	2	1	2	2
		E02	Presence of supportive local organizations	2	2	1	2	2
		E03	Compatibility of CA to local customs and/or norms and rules	1	2	2	2	2
		E04	Land access, ownership and used	0	0	2	1	2
		E05	Household spatial distribution and effect on CA adoption	0	1	2	2	1
F	Market conditions for CA inputs and outputs	F01	Availability of markets for CA products	0	2	0	1	0
		F02	Accessibility of markets for CA products	0	2	0	2	1
		F03	Availability of interest from CA economic actors	2	2	1	1	1
		F04	Availability of basic infrastructure for CA adoption target group	2	1	1	1	1
		F05	Availability of quality control structures, e.g., certification	2	2	0	0	1
G	Perception of CA adopting community.	G01	Acceptability of CA by community	2	2	1	2	2
		G02	Acceptability of CA by village leaders/elders	2	2	2	2	2
		G03	Acceptability of CA by young farmers	0	1	0	1	1
		G04	Acceptability of CA by target group (farmers)	2	1	2	1	1
		G05	Social acceptability of individual engagement in CA	1	2	2	2	2
		G06	Availability of a dynamic and innovative community	2	1	1	1	1
			Total number of factors (n)	53	53	53	53	53
			n Supporting factors (2)	36	40	24	35	34
			n Potential hindering factors (1)	08	12	18	17	17
			n Hindering factors (0)[15]	09	1	11	1	2

[15]Values 0, 1 and 2 stand for the QAToCA scale, indicating the weight/strength of the suggested statement with respect to its influence on the potential of adoption with 2 being the most influential (maximum positive effect on adoption) and 0 being the least suitable (no positive effect, possible negative effect on adoption), following Ndah et al. (2012)

5.6 Discussion of results

In this paper, we demonstrate how a newly developed approach (Qualitative expert Assessment Tool for CA adoption—QAToCA) (Ndah et al. 2012) was used to assess the adoption potential of site-specific CA practices across SSA.

According to the results, the cases of Malawi, northern Burkina Faso and Zambia exhibit a high CA adoption potential. On the other hand, the eastern Zimbabwe and southern Burkina Faso cases both show a low adoption potential for CA. These results are discussed in detail in the paragraphs below, following the respective case study areas. Guided by the study's objectives, the discussion focuses on the general implications of the QAToCA assessment compared with real adoption estimates. The discussion also explores the influence of the respective thematic categories of QAToCA (i.e., institutional, socio-economic and cultural factors) as well as the role of supporting and hindering factors on the overall CA adoption process for the respective case study areas.

5.6.1 Southern Burkina Faso (W1)—Western Africa

There are two possible explanations for the contradiction between the projected high CA adoption potential (reflected more from the institutional perspective) and the observed low estimates for case W1: 1) the possibility that while the potential to nurture real CA adoption for this region does exist (e.g., enabling institutions, promotion strategy, compatibility with societal norms, etc.), unfortunately, these avenues have not been exploited to actually transform them into CA dissemination; and 2) the possibility of a biased assessment from the QAToCA workshop participants, an aspect which cannot be completely ignored.

Although factors in the institutional category project a high CA adoption potential for the southern Burkina Faso case study, a close look at other thematic categories of QAToCA (e.g, F, market conditions for CA inputs and outputs) as well as observed estimates of CA adoption suggest only relatively little potential for CA adoption. At the beginning of the project, Kassam et al. (2010) estimated the potential for PRODS/PAIA project outreach in this region to be 20,000-30,000 farmers. However, following an inventory and regional workshop feedback from the EU funded project, CA2Africa (2012) (www.ca2africa.eu), observed adoption of CA practices in this area appeared to be very low. Apart from unfavorable market conditions, low adoption is caused by farmers' conflicting needs to use crop residue for

livestock or mulching and most small scale farmers prioritized its use for feeding purposes (see also Magnan et al. 2012).

QAToCA also identified the absence of quality check and implementation structures (F05). This is reflected in the continuous adaptation of the standard CA package to fit the specific adoption context. The absence of these structures could be regarded as a hindering factor mostly in areas where there is strict focus on CA implementation following the three principles as suggested by FAO (2008). However, since farmers almost universally adapt the CA package to their context, needs and opportunities, the absence of such structures may not actually represent a major problem to CA adoption in the broad sense. As a package, CA is often seen as too complex, hence the need for adaptation, which is a concern equally shared by Erenstein et al. 2012). However, to boost CA adoption in this region, stakeholders need to carefully consider and take advantage of the characteristics of CA (A); and the political and institutional frame conditions at village and regional levels (D and E, respectively) (**Fehler! Verweisquelle konnte nicht gefunden werden.**), which are both thematic categories which have a positive influence on CA adoption potential for the region.

5.6.2 Northern Burkina Faso (W2)—Western Africa

In this case study, there is consistency between the relatively high adoption potential of the Zaï system as identified with QAToCA and the relatively high adoption rate observed. According to Slingerland and Stork (2000), an estimated 46,000-51,000 ha of cropland are under Zaï in the Yoka region, while Kabore and Reij (2004) as well as Hien and Quédraogo (2001) have an estimated 23,000-31,000 ha in the Donsin region and 8,000-18,000 ha in the Yatenga region, respectively. In addition, the CGIAR Group (2011) reports about 300,000 ha. According to our interviews in 2011, Zaï is being practiced by 92 out of the 100 interviewed farmers in five villages across the case study region.

The high adoption potential for the adapted CA practice (Zaï system) in this region (W2), therefore, corresponds to observed results—findings also confirmed by IFAP (2005). The economic return on land under Zaï is 100% since land brought under production was initially abandoned. As a land rehabilitation technology, Zaï is used to rehabilitate degraded dry lands and restore soil fertility. It is further regarded as an indigenous practice that fits well with the farmers' local environment, hence its higher adoption potential (Ouedraogo and Bertelsen

1997). This is probably why farmers identify more closely with it as opposed to innovations introduced from outside the region.

Nevertheless, Zaï is a labor intensive practice with a labor demand of 300 man-hours/ha; this requirement, however, depends on soil types (Kabore and Reij 2004). Maintenance is also labor-intensive, and mechanization is impossible since pits are dug and maintained by hand. In spite of this limitation, this technology remains the best option for farmers—offering a way to grow crops in marginal areas where it would otherwise be impossible to improve production. This certainly explains why the assessed adoption potential is high for this region and corresponds to observed estimates as well.

To maintain and stabilize a sustained adoption of the Zaï practice, stakeholders need to carefully consider the following identified negative effects on adoption for the region: 1) a weak pattern of collaboration among regional agencies, institutions, NGOs, civil society and the private sector (Kassam et al. 2010) and 2) poor market conditions for CA inputs and outputs (F).

5.6.3 Eastern Zimbabwe (S1)—Southern Africa

For this case study, the QAToCA assessment indicates a relatively limited potential for CA adoption in contrast to the observed national adoption rates which seem to be high (FAO 2012b). Observed CA adoption in Zimbabwe has increased rapidly from 8,900 farmers in 2005 (in 50 wards) to 286,000 farmers in 2011 (in 680 wards), (FAO 2012a). It should be noted that the QAToCA results refer to particular regions (Goromonzi and Murehwa in northeastern Zimbabwe—Mashonaland) while the FAO estimates are for the whole country.

The discrepancy in potential and observed adoption may also be explained by noting that the FAO adoption rates refer to project-driven adoption rather than sustained adoption (Andersson et al. 2012). However, FAO figures are based on project reports with adoption numbers that are often overestimated. ZCATF (2009), for example, argues that even though CA uptake in Zimbabwe has increased rapidly since 2005, a large proportion of the farmers rely on NGO support, including access to CA equipment. Under such circumstances, project-driven adoption is often short-lived and likely to fall back once the source of support stops (Boahen et al. 2007; Ndah et al. 2011). Observed, sustained adoption is, therefore, likely to be much lower than the reported figures, and the results will likewise vary greatly if there is wider consideration of the different natural regions, farm types and typologies, and wealth

endowment. Similarly, data provided by Zvigadza *et al.* (2010) and Mazvimavi *et al.* (2008), all indicate that poor market conditions for CA inputs and outputs seem to be limiting CA adoption. For instance, without the necessary inputs such as CA machinery, adapted tools, legume seeds and herbicide, farmers find it difficult to engage in a sustainable CA farming process. In addition, the absence of markets for their produce goes a long way to discourage farmers since their yields are not easily converted to the needed cash for household demands. Factors further identified as possibly hindering CA adoption in this region include: limited access to herbicides, livestock competition over crop residues, sandy soils and limited biomass production. The low CA adoption potential for Zimbabwe detected with QAToCA, therefore, seems to confirm the conclusion by Baudron *et al.* (2012 pp 1) that *"small scale farmers in southern Africa are predisposed towards extensification rather than intensification and that a widespread adoption of CA in the region seems to be unlikely"*. However, this conclusion allows room for a much deeper reflection and further research on CA adoption processes in Zimbabwe.

5.6.4 Malawi (S2) and Zambia (S3) – Southern Africa

QAToCA results show a relatively high CA adoption potential for Malawi and Zambia, which corresponds with the observed adoption situation (especially for Zambia, though only nationwide estimates could be found). Observed estimates for Malawi show that Total Land Care (the main promoting organization of CA) has reached out to about 32,000 farmers who are now practicing CA on a total surface area of 12,830 ha (NCATF 2012). Nationwide, aggregated numbers of CA adopters in Malawi stand at 84,298 farmers on a total surface area of 13,673 ha (NCATF 2012). In the case of Zambia, the number of farmers practicing CA in the whole country by 2003 was estimated to be 20,000 to 60,000 (Haggblade and Tembo, 2003). In 2010, CFU-Zambia estimated 190,400 farmers (Aagaard 2010; Aagaard 2012) while FAO reports have estimated that more than 200,000 farmers were practicing CA in Zambia (FAO, 2012b; Nyagumbo 2010, unpublished).

High adoption rates can be mainly attributed to the intense institutional arrangements and history of promotion efforts in these two regions (Table 1). In addition, labor reduction and yield increases experienced by adopting farmers also play an important positive role. While CIMMYT and TLC with other national and international bodies are responsible for the positive picture of CA adoption in Malawi (Mloza-Banda and Nanthambwe 2010), CFU, GART and other supporting organizations in Zambia are accountable for the state of adoption

in Zambia (Nyanga 2012). Some organizations, especially CFU, have adopted the "*step by step*" approach in guiding farmers towards eventually adopting a full CA package (Aagaard 2011, unpublished; Nyagumbo 2008). In addition, the issue of market conditions for CA inputs and outputs (F), is seen as a hindering factor in most case studies (e.g., cases S1, W1 and W2), although market conditions partly[16] exert a positive influence on the CA adoption potential in Malawi. This is further confirmed in the CIMMYT (2012 pp 1) quarterly newsletter which states: "*linking farmers to input markets in Malawi has been a major success but more work needs to be done to equally develop output markets for increased production from CA fields"*.

The highly organized extension system is responsible for the positive state of adoption in both Zambia and Malawi cases. This certainly explains why characteristics of CA as an object of adoption (A), has a positive assessment for both Malawi and Zambia. CFU Zambia has a well-structured extension system (Nyanga 2012) which puts experts in farmers' immediate reach. There is further integration of the lead farmer approach (Haggblade and Tembo 2003), which facilitates improved extension service delivery, intensive training, private sector involvement to provide input and equipment, use of hands-on staff and an electronic voucher system for input delivery in Zambia (Nyagumbo 2008). With exposure to immediate technical assistance, farmers have a high chance for improved understanding of the technical characteristics of CA—hence a reason for the higher potential and observed adoption.

5.7 Discussion of the method

QAToCA provides a relatively simple picture of the CA adoption potential which can be used as a basis for restitution and discussions with stakeholders' by: 1) providing insights into the specific CA development and diffusion programs and projects and 2) providing entry points for planning/adjusting some of the on-going and future CA-related actions. The results also form a knowledge base towards understanding CA adoption's supporting and hindering factors under the different agro-ecological, socio-economic, institutional and cultural conditions of Africa.

However, this methodological design (Ndah et al. 2012) like any approach might have its own limitations. First, there is always the possibility of bias on the part of promoting organizations

[16]Labor savings, higher yields, moisture conservation, etc. are also reported to be main drivers of adoption in Malawi.

invited to the assessment workshops, which might influence the outcome, so this must not be underestimated. Varying the group composition of a QAToCA workshop as well as the group size may influence the final results. Future research on QAToCA could try to document this bias. It could also test the approach in one counterfactual site for each case study as this may strengthen the credibility of its outcome as well as minimize the possibility of site selection bias. Other challenges may include expanding the assessment approach further to capture effects of global change episodes (e.g., climate change and changes in economic dimensions) on CA adoption.

Aside from the un-weighted aggregation of criteria used for quantification in QAToCA, its result is already a worthwhile development. In its current state, QAToCA does not deal well with the potential existence of limiting factors which may be important for adoption. Despite such weaknesses, the QAToCA approach currently minimizes the strict quantitative interpretation of CA farmers' adoption decision behavior by looking at the regional picture and not at factors which could affect adoption on an individual case. QAToCA attempts to take into account the innovation systems context—with a holistic consideration of influencing factors and with farmers having the option of adopting modified practices. Also, a farmer's decision to adopt CA is driven more by the relative advantage offered by the technology over his previous conventional farming practice (e.g., difference in labor, cost, yield, etc.). Before adopting CA, farmers may already use some components of CA in their conventional farming which they could already identify with and use as an entry point to either partial or full CA adoption (rotation, tillage reduction, mulching). The presence of a limiting factor directly affecting rotation, reduced tillage or mulching would only affect adoption negatively by slowing it down, hence minimizing the chances for a rapid wide scale adoption for a given community. Partial adoption is common because of some limiting factors' overriding effects, and these form the basis for most of the adapted CA practices. The choice of a qualitative approach within the QAToCA approach, therefore, has been driven by the objective to gain a holistic overview of the logic of CA adoption, its arrangements, and its explicit and implicit rules (Punch 2005).

5.8 Conclusions

In attempting to bridge knowledge gaps in the adoption processes of CA practices across SSA, this paper has focused on applying the QAToCA approach to assess the adoption potential of these practices as introduced on the ground in five contrasting case study areas.

According to the assessment, adoption potential of CA practices varies between case study regions across SSA. The results show that for the case of Malawi, northern Burkina Faso and Zambia, assessed CA adoption potential is high; while the eastern Zimbabwe and southern Burkina Faso cases both show a low adoption potential for CA. A close examination of these results alongside literature on real adoption (observed adoption) indicate that the QAToCA results in some cases deviate from observed CA adoption estimates (e.g., southern Burkina Faso and Zimbabwe), while in others, the results are consistent with observed adoption rates (e.g., Zambia, Malawi and northern Burkina Faso). Although some possible explanations are proposed explaining the consistency or inconsistency in assessed QAToCA results versus observed estimates of CA adoption, the probability of a possible limitation in the methodological design for the QAToCA approach used cannot be completely ignored, hence the need for future expansion and further improvement of the approach. The approach, however, does provide a quick, holistic assessment guide at scales seldom tackled by CA initiatives. Results obtained through QAToCA can help CA researchers, practitioners and other managers of on-going projects in these regions to reflect on their CA-related activities and eventually adjust or redesign them based on a more explicit understanding of where problems and opportunities are found.

Specifically, the QAToCA assessment suggests the need for concerted efforts and careful consideration of the following key hindering factors in any effort aimed at achieving sustained adoption of the respective site-specific CA practices: 1) competition and conflict over resources (residue) between CA and livestock especially for southern Burkina Faso; 2) market conditions for CA inputs and outputs in the cases of Zimbabwe, northern and southern Burkina Faso; 3) CA network and connectivity in the case of northern Burkina Faso; 4) type of communication channels, availability of quality control structures and technical characteristics of CA in the case of Zimbabwe; 5) complexity of CA as a package; 6) limited acceptance of CA by young farmers in both Zimbabwe and Zambia; 7) need for an enabling administrative and policy environment at the village level in Zambia; and 8) the issue of land access, ownership and use in both Malawi and Zambia.

In summary, the findings of this paper suggest that in any effort towards improving the general environmental management practices of farmers, especially with regards to the introduction and adoption of new technologies or sustainable management practices, the issues of 1) market conditions for such technologies and 2) the general characteristics of such

technologies as objects of adoption need to be carefully considered. In addition, there is a strong need for enabling political and institutional frame conditions especially at the village level in case study areas where sustainable management practices like CA are being introduced.

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CHAPTER 6

OVERALL CONCLUSIONS

6 Overall Conclusions

With a focus on Fish Farming and Conservation Agriculture as examples of Agricultural innovations in Africa, this work has 1) partly demonstrated that the reality of the adoption and diffusion of agricultural innovations in Africa is a much more complex issue, 2) improved on the knowledge and understanding of contextual factors influencing the adoption and diffusion of these innovations in Africa and, 3) developed and contributed to a new methodological approach in this field of study. To realise these goals, as well as organise this work to meet the requirements of a PhD thesis, the work has been structured in form of chapters corresponding to published articles (article I, II and III) in scientific peer reviewed journals. The following sub sections highlight overall conclusions derived from this entire thesis.

6.1 A reflection on adoption theories and concepts

The study started by making an indebt review of selected adoption theories and concepts which have subsequently been applied as frameworks for analysis in the respective chapters (articles) of this thesis. Though the selected theories and concepts all provide frameworks with potentials to studying the adoption processes of the two innovations (Fish Farming and Conservation Agriculture), each theory or concept is seen to have its strength as well as limitations in the conceptualising process. This is reflected mostly in the specific angle/dimensions to which each of them focuses in relation to the adoption decision process. It is realised that most of these theories or concepts captures either one or two of the many necessary angles that explain the inherent complexity of the whole issue of adoption and diffusion process of innovations. While some theories/concepts cover mostly the individuals and factors affecting their behaviour, ignoring the more institutional ones, others suffer from the opposite problem with emphasis on institutions and policies, but overlook the individual dimensions.

Nevertheless, while each theory/concept brings a unique contribution as a potential framework for explaining adoption and diffusion processes of innovations, the Diffusion of innovation Theory (Rogers 2003), and the innovation systems approach (World Bank 2006) are especially interesting not only as they have been designed and tested specifically for the field of agriculture, but because they offer the most generic (encompassing) framework for analyzing systems of innovations adoption and fit well to the context of Fish Farming and Conservation Agriculture. With regards to the nature of adoption process, the theory of behaviour modification(Hruschka 1994) and the Dynamics of CA adoption (Triomphe et al.

2007) are seen to be quite fitting. These theories/concepts therefore constitute the backbone/framework of the various articles which form the core of this work. Summarily, what each of these theories/concept brings to the overall framework in terms of levels, factors, processes, include amongst others: 1) *the specific agro-environmental circumstances, 2) the insufficiently adapted technology, 3) the knowledge of farmers, 4) the economy of small scale farmers, 5) the societal acceptance of innovations, 6) the availability of resources, 7) CA Adoption Context, 7) Stakeholders within the CA innovation system, 8) Type and quality of linkages between the stakeholders.*

6.2 Applied methodology approach

Empirical data collection for this study has been derived mostly with the use of mixed Participatory Rural Appraisal (PRA) methods such as semi structured farmers and expert interviews, focused group discussions, key informant interviews, participant observations. The QAToCA approach, developed as a method within these work has equally been tested and applied within this study as a very useful qualitative participative assessment method especially for chapters 4 and 5 to realise the specific objectives of these chapters. A combination of methods as such has assisted in the triangulation of results hence contributed to 1) obtaining reliable results and, 2) successful realisation of the entire PhD project.

6.3 New insights into factors influencing the adoption of Fish Farming in SSA

With regards to results, on Fish Farming, examined specifically under chapter 3, this study has revealed that this innovation in Africa, especially for the case of Cameroon, is mostly attractive for medium-scale farmers. However, for a sustained adoption of this innovation in SSA therefore, there is the need of: 1) targeting support to medium-scale farmers, 2) improving organisational structures of farmers, 3) strengthening the fragile extension system, and 4) improving research for fingerlings production. Most farmers are still in a state of trial, and ready to interrupt the activity as soon as problems occur, e.g., infrastructural problems or low economic demand. Additionally, external support is frequently in the frame of international projects, i.e., within a given time frame, and public extension services are nearly negligible. However, a certain number of farmers have reached the state of performing production and mastery. If these successes are to grow, more support for innovating farmers is needed, both in terms of access to knowledge and infrastructural resources. Then, population

growth and increasing demand for fish in towns and centres might do its part and serve as an attractive market.At the national levels, the public sector has basically failed in its functions. The private sector is proving to be the better partner and it is fast gaining the support and confidence of the farmers. For the specific case of Cameroon, Fish Farming is still in the critical phase of the diffusion process. In several cases, the appraisal of the innovation's characteristics coincides with either fostering or hindering factors as perceived by the farmers. More specifically, 1) the inconvenient complexity of the innovation in, for instance Cameroon, corresponds very well with the observed absence of public training and extension support, 2) the uncontested fact of observability makes Fish Farming worth a trial also under conditions of low effective demand and hence for family or local consumption and 3) the compatibility of observed Fish Farming reflects the fact that though there is a certain dominance of inhibiting factors, there is still as well an accommodating socio-cultural environment to this activity.

6.4 New insights into adoption and diffusion process of CA in SSA

On the other hand, for Conservation Agriculture (chapters 4 and 5) field surveys using the QAToCA approach complemented by Semi-Structure interviews have been carried out in seven case studies spread across six countries in SSA (Zambia, Zimbabwe, Malawi, Burkina Faso, Kenya and Tanzania).

Based on QAToCA's first application in Bungoma (Kenya) and Karatu (Tanzania), results revealed that market conditions for CA inputs and outputs are outstandingly hindering adoption potential of CA. This was specifically mirrored through the need for 1) accessibility of markets for CA products; 2) inputs, such as legume seeds and adapted CA machineries; 3) basic infrastructure for CA adoption target group, such as farms to market roads; 4) introduction of quality CA implementation measures; and 5) a renewed motivation and interest amongst CA service providers. However, a close look at the determinants reveal a certain dominance of supporting over hindering factors with a heavy presence of promoting institutions (especially for Bungoma case) positively influencing the CA adoption potential. Nevertheless, a sustained scaling up in CA adoption could mostly be witnessed if concerted efforts are made towards improving on the needed basic infrastructures for CA adoption such as market access and roads, credit facilities and adapted CA equipment for this region. In addition, results of its later application in southern and western Africa show that for the case of Malawi, northern Burkina Faso and Zambia, CA adoption potential is high; while the

eastern Zimbabwe and southern Burkina Faso cases both show a low adoption potential for CA. A close examination of these results alongside literature on real adoption (observed adoption) indicate that the QAToCA results in some cases deviate from observed CA adoption estimates (e.g., southern Burkina Faso and Zimbabwe), while in others, the results are consistent with observed adoption rates (e.g., Zambia, Malawi and northern Burkina Faso). Specifically, the QAToCA assessment suggests the need for concerted efforts and careful consideration of the following key hindering factors in any effort aimed at achieving sustained adoption of the respective site-specific CA practices: 1) competition and conflict over resources (residue) between CA and livestock especially for southern Burkina Faso; 2) market conditions for CA inputs and outputs in the cases of Zimbabwe, northern and southern Burkina Faso; 3) CA network and connectivity in the case of northern Burkina Faso; 4) type of communication channels, availability of quality control structures and technical characteristics of CA in the case of Zimbabwe; 5) complexity of CA as a package; 6) limited acceptance of CA by young farmers in both Zimbabwe and Zambia; 7) need for an enabling administrative and policy environment at the village level in Zambia; and 8) the issue of land access, ownership and use in both Malawi and Zambia.

6.5 Contribution to a new methodological approach in this field

In contributing to methodological approaches in this field of study, a participatory assessment approach (QAToCA) has been developed within the frame of this work. In spite of the noted limitations of the developed approach, its publication in scientific journals and continuous use as a research tool in Africa makes it already a worldwide invention. QAToCA results 1) gives a picture of the relative adoption and diffusion potential of CA across SSA, 2) forms a basis for restitutions and discussions with stakeholders of the various case studies, in providing new insights into the specific development and diffusion programs, 3) provide entry points for planning /adjusting some of the on-going and future promotion efforts, 4) provide a knowledge base towards the understanding of supporting and hindering factors for the adoption of innovations (especially CA) under specific; agro-ecological, socio-economic, institutional and cultural conditions of SSA.

6.6 Impact on general environmental management and technology uptake

In summary, findings of this work suggest that in any effort towards improving the general environmental management practices of farmers, especially with regards to the introduction

and adoption of new technologies or sustainable management practices, the issues of 1) market conditions for such technologies and 2) the general characteristics of such technologies as objects of adoption need to be carefully considered. In addition, there is a strong need for enabling political and institutional frame conditions especially at the village level in case study areas where sustainable management practices like Conservation Agriculture and Fish Farming are being introduced in SSA.

6.7 References

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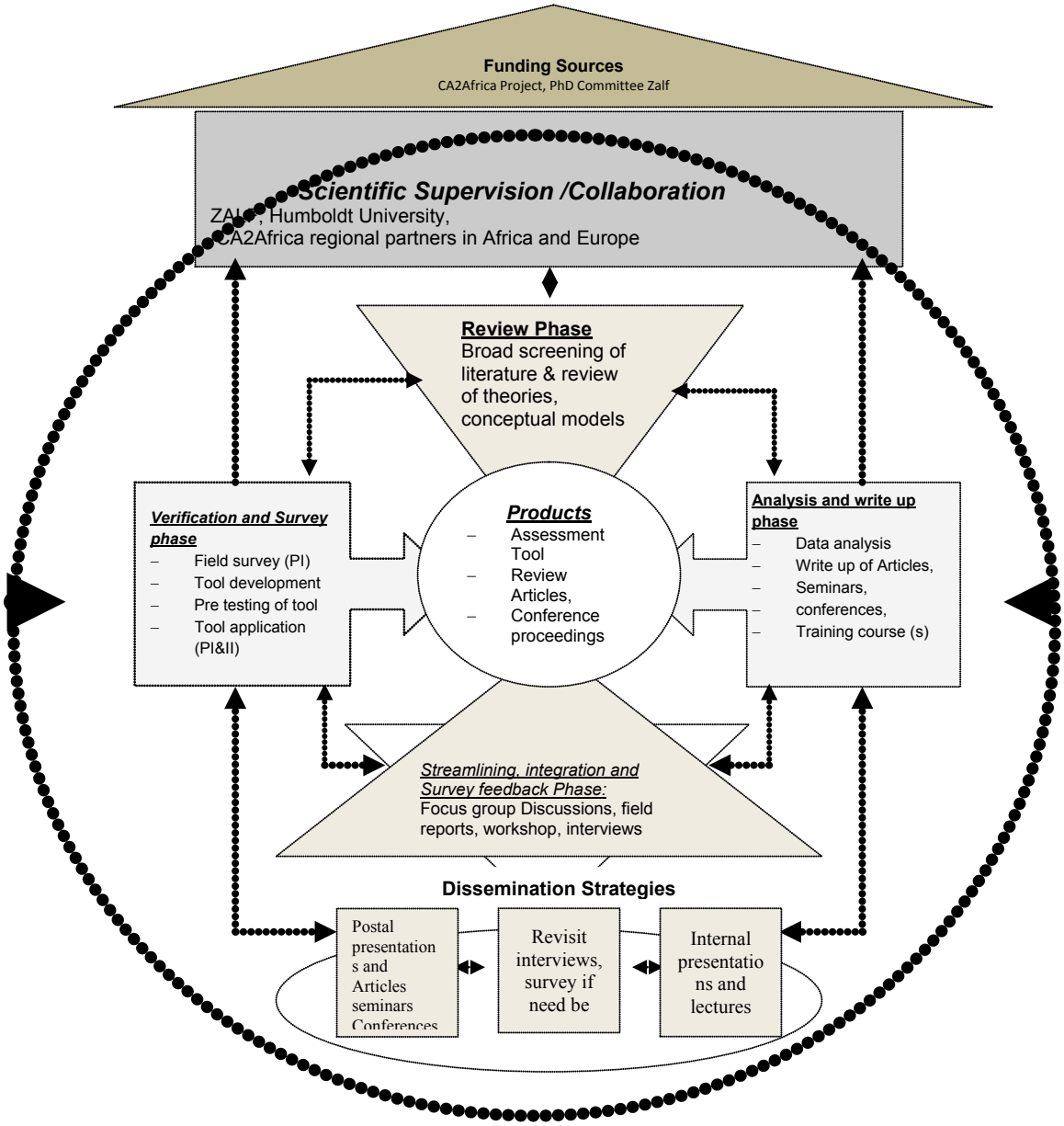
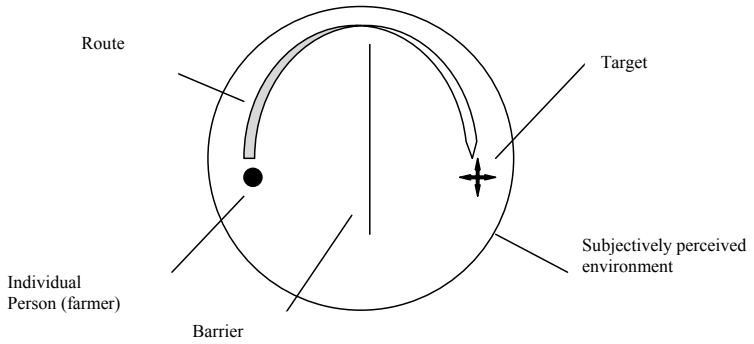
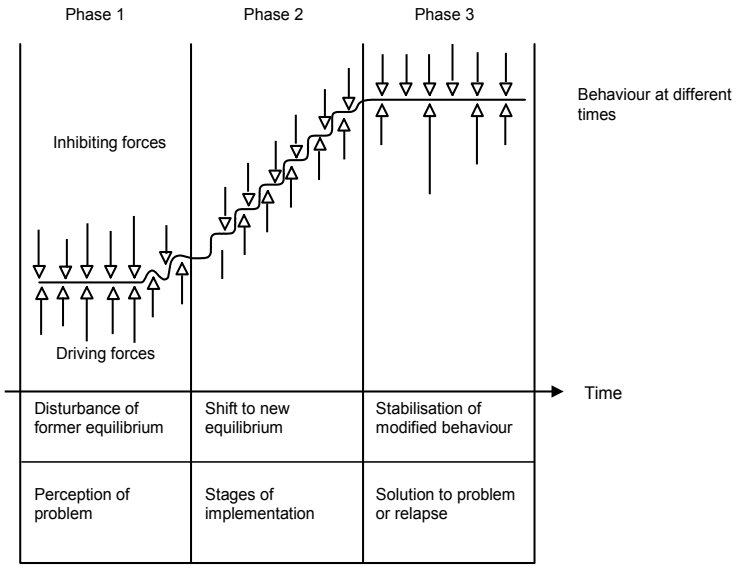
7 Appendix

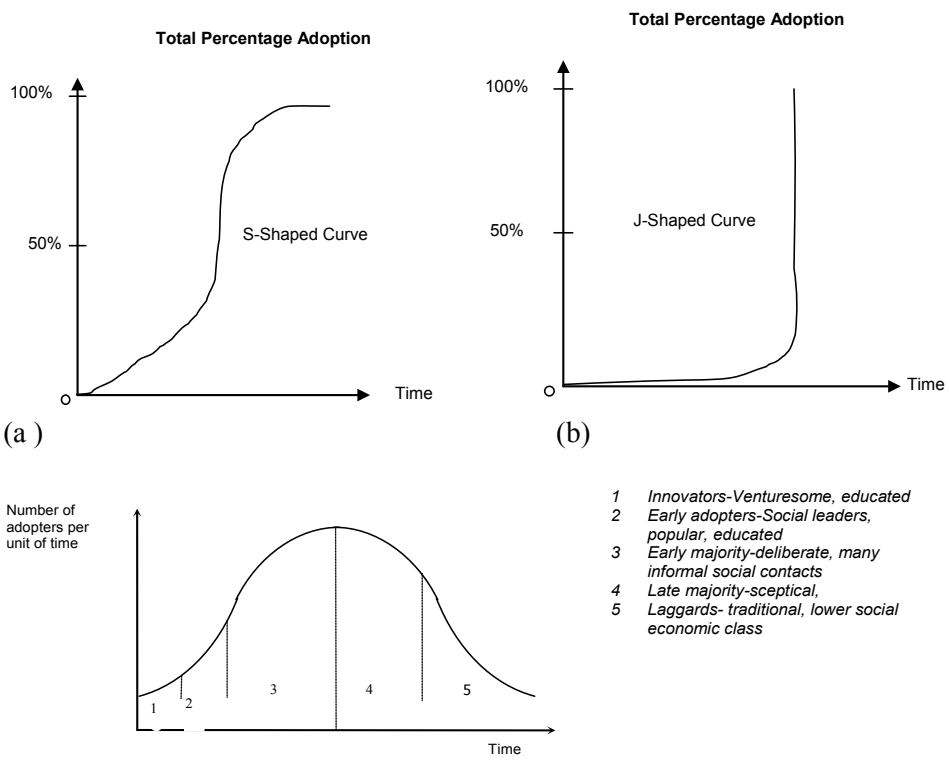
7.1 Holistic structure (view) of the PhD work

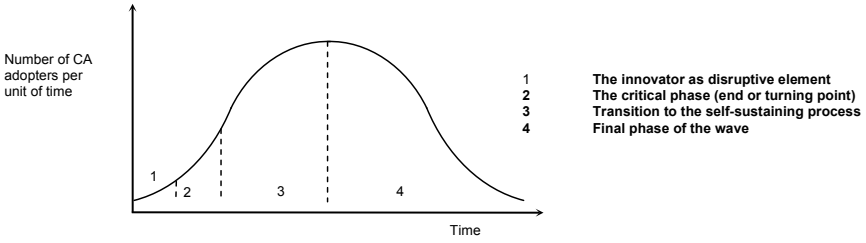


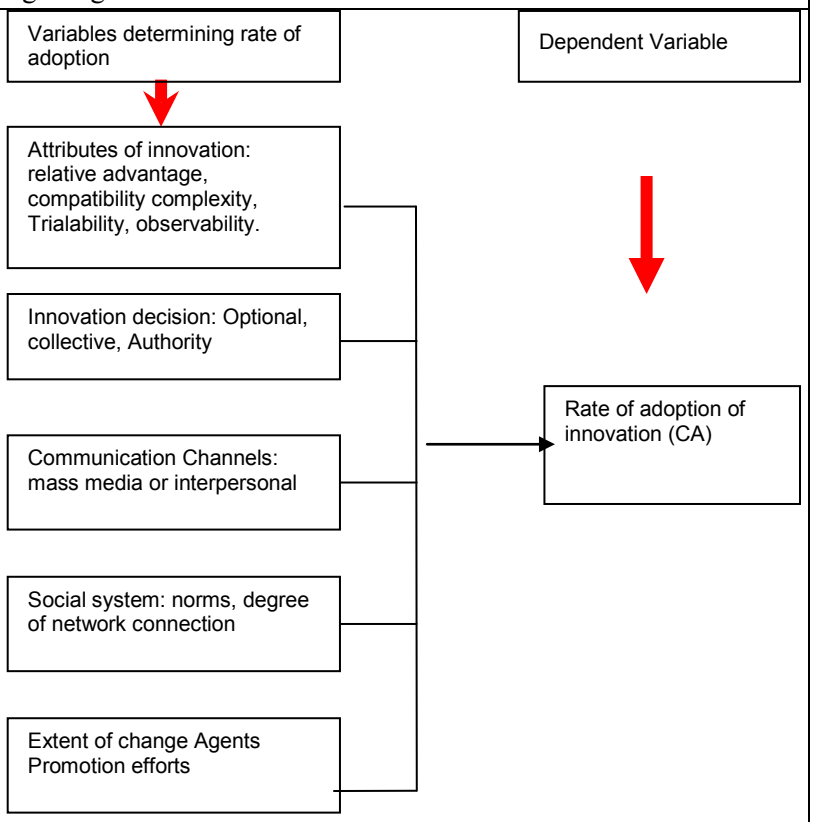
7.2 Brief summary and graphical illustrations of reviewed theories and Concepts

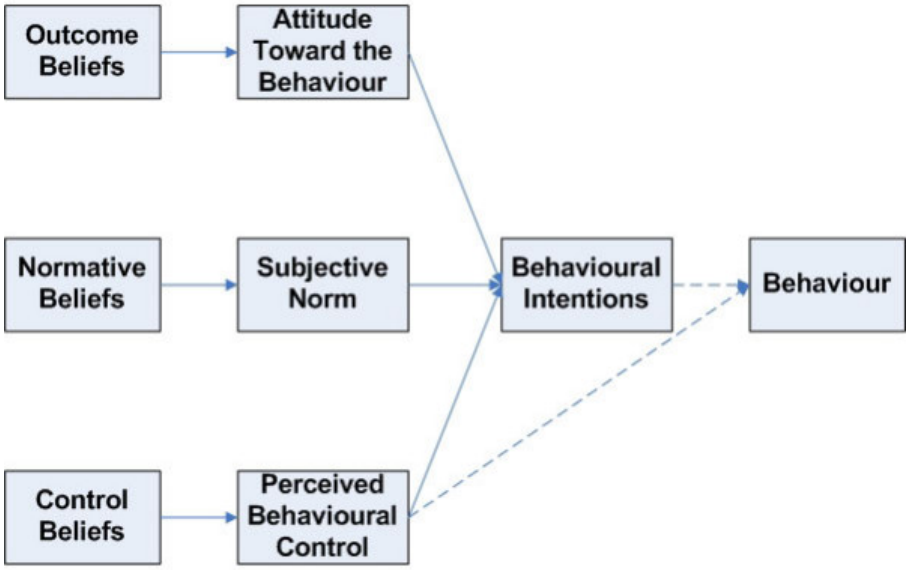
Theory	***Theory of Psychological field***
Scope	Conceptualization of Psychological field within which an individual (farmer) experiences obstacles that prevent him from reaching his target (Adoption)
Scale	Farm, Village
Graphical representation	
Key message	Theory focuses on the concept that for a change of behaviour to occur (for instance changing from Conventional farming to CA), this depends on/is a function of the individual (farmer, b) and his subjectively perceived environment (*Esubj.)* i.e. $b = f(P, Esubj....)$
Key publications	Lewin (1947)

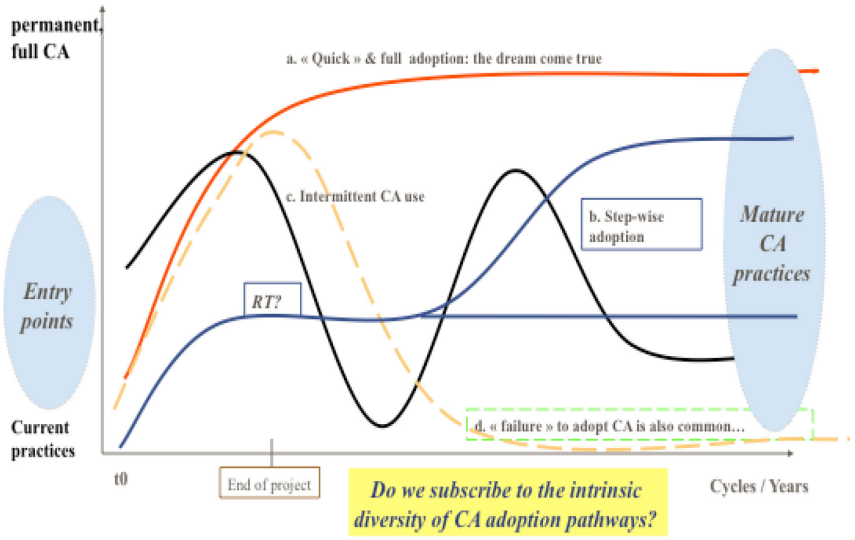
Theory	***Theory of Behaviour Modification***
Scope	Conceptual illustration of behavioural change phases and how inhibiting and driving forces interplay in the behavioural change process (Adoption)
Scale	Farm, Village Level
Graphical representation	
Key message	Theory focuses on the concept that for a change of behaviour (CB) to take place (for instance changing from Conventional farming to CA), there is need for the addition of Driving forces (DF) to CA as well as removal of some Inhibiting forces (IF) or both i.e. CB=+DF-IF
Key publications	Albrecht et al.(1989); Hoffmann (2005); Lemma (2007); Ndah (2008)

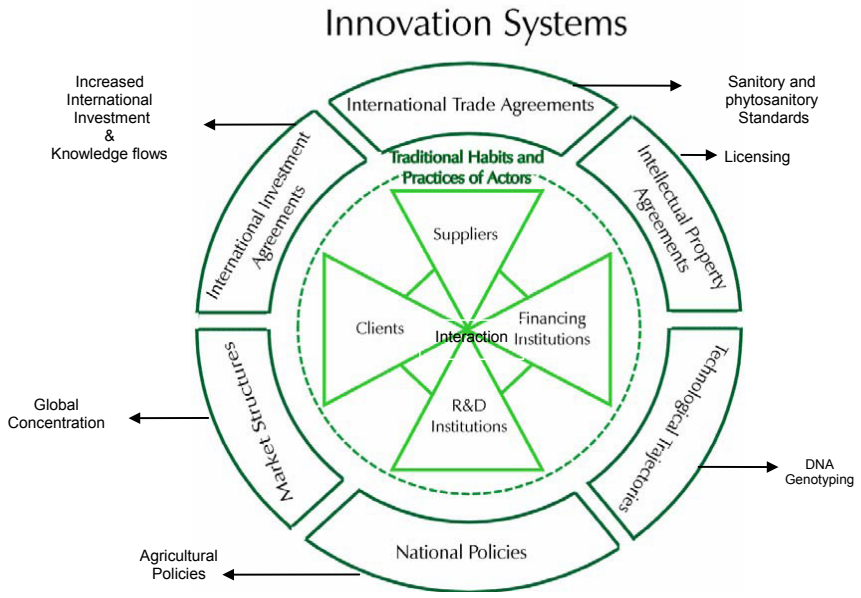
Theory	***Diffusion of Innovation theory***
Scope	Conceptual illustration of possible diffusion phases (a, b), categories of adopters in the adoption process (c)
Scale	Village/Regional Level
Theory/Conceptual Model	Diffusion of Innovation Theory
Graphical representation	
Key message	Theory states that there are two possible paths for the adoption process. First, it can take off swiftly once the innovation is introduced and falls at a later stage (s-shaped curve). Second, it can delay at the early stage and take off swiftly but at a later stage (J-shaped curve). In any case, the adopters are classify in categories from 1 to 5 and when display as number of adopters per unit of time, this forms are bell-shape curve or normal distribution as shown in "b" above.
Key publications	Rogers(2003); (Ndah 2008); (Kriesemer and Grötz 2008); Hoffmann (2006),

Concept	***Hohenheim diffusion concept***
Scope	Conceptual illustration of phases in the diffusion process
Scale	Village/Regional
Graphical representation	
Key message	Concept describes the various phases in adoption diffusion process. States that an innovation goes through four phases with the innovator regarded in the first as a trouble maker or disruptive element. The second phase is regarded as the critical phase and the adoption process is assumed to at least start off. It is assumed to move into a self sustaining process once it crosses stage three. The last phase called final phase of the wave is assumed to be a natural phase for every innovation as it will always have a life span after which it is replaced by a much modern a better discovery.
Key publications	Hoffmann(2005), Ndah (2008), Lemma (2007)

Concept	***Variables of adoption***
Scope	Conceptual illustration of determinants of adoption
Scale	Farm /Village/Regional level
Graphical representation	
Key Message	Rogers (2003) refers to an innovation (CA) as a dependent variable while those factors which determine its rate of adoption are called independent variables. Attributes of an innovation (trainability, compatibility, relative advantage, complexity and Observability) are identified as the very first determinant of adoption. This is closely followed by the Innovation decision, Communication channels of the set innovation, the nature of the social system and lastly by the extent/capacity of the promoting agents. Each of these the listed attributes have a negative or positive role to play towards the adoption process. For instance, trialability, observability, compatibility are all positively correlative with the rate of adoption unlike complexity which has a negative correlation etc.
Key publications	Rogers(2003), Hoffmann(2005), Ndah (2008), Lemma (2007), Sattler et al (2003**)**

Theory	***Theory of Planned Behaviour***
Scope	Conceptual illustration of beliefs and factors which influence intention and behaviour (For instance adoption behaviour)
Scale	Farm/Village
Graphical representation	
Key message	Theory states that human action is guided by three kinds of considerations: • Behavioural Beliefs (beliefs about the likely consequences of the behaviour-adoption) • Normative Beliefs (beliefs about the normative expectations of others) • Control Beliefs (beliefs about the presence of factors that may facilitate or impede performance of the behaviour-adoption). Ajzen's three considerations are crucial in circumstances such as projects (e.g CA2Africa) when considering attitude towards a practice (CA). In combination, the three considerations lead to the formation of a behavioural intention. As a general rule, the more favourable the attitude and subjective norm and the greater the perceived control, the stronger should be the person's intention to perform the behaviour (adopt CA)
Key publications	Ajzen, 1991 Wauters E (2005)

Concept	**Dynamics of CA adoption**
Scope	Conceptual illustration of possible phases of adoption (Adoption pathways)
Scale	Farm/Village/Regional / project
Graphical representation	
Key message	1 Entry points (how to start changing current practices) and end points (in the graph: mature CA practices) vary from situation to situation 2 Adoption pathways are diverse, and may not all need to adoption of permanent, full CA 3 Failures and non-adoption may be an outcome 4 Projects may trigger initial adoption but this does not mean it will be sustainable over time
Key publications	Triomphe et al. 2007

Concept	***Innovation systems approach***
Scope	Conceptual illustration of various sectors in an innovation system
Scale	Village/Regional/International level
Graphical representation	
Key message	Concept of Innovation is stressed as a System which comprises of all actors and their interactions involved in the production and use of knowledge and the rules and mechanisms at both the institutional and policy context level that shape the processes of knowledge access, sharing and learning". Further consideration is given to the following aspects. • It is necessary to take into account the dynamics of the innovation process over long periods of time (20 years or more) • It is necessary to identify and characterise key actors, their attitudes, their practices, their roles • Linkages with markets are crucial but as a structuring factor for innovation and as a driving force for innovation. • Coordination and collaboration among stakeholders is at the heart of a successful Innovation prices / system • The enabling environment needs to be taken into account in its diverse dimensions (institutions, policies, etc.) • *Research an important but no sufficient component of a successful innovation*
Key publications	(World Bank 2006) (Lundvall 2004) (Mytelka 2000)

8 Statutory declaration

I hereby declare that I wrote the present dissertation with the topic: "Adoption and adaptation of innovations: Assessing the diffusion of selected agricultural innovations in Africa", independently and used no other aids that those cited. In each individual case, I have clearly identified the source of the passages that are taken word for word or paraphrased from other works.

I equally declare that this dissertation has not been part of a doctoral procedure before, and that this is my first doctoral program and I have not been holder of doctoral degree before.

I also hereby declare that I have carried out my scientific work according to the principlesof good scientific practice in accordance with the current rules and regulations of Humboldt University of Berlin, for assuring Good Scientific Practice.

Berlin, 06.06.2014

……..

Place, Date

9 Erklärung

Ich erkläre, dass ich die Dissertation ausschließlich auf der Grundlage der angegebenen Hilfsmittel selbständig angefertigt habe.

Ich erkläre weiterhin, dass ich weder an der HU noch an einer anderen Universität bereits einen Promotionsantrag gestellt habe bzw. einen entsprechenden Doktorgrad besitze.

Ich erkläre außerdem, dass ich die dem angestrebten Verfahren zugrunde liegende

Promotionsordnung zur Kenntnis genommen habe.

Berlin, 06.06.2014

……..

Ort, Datum